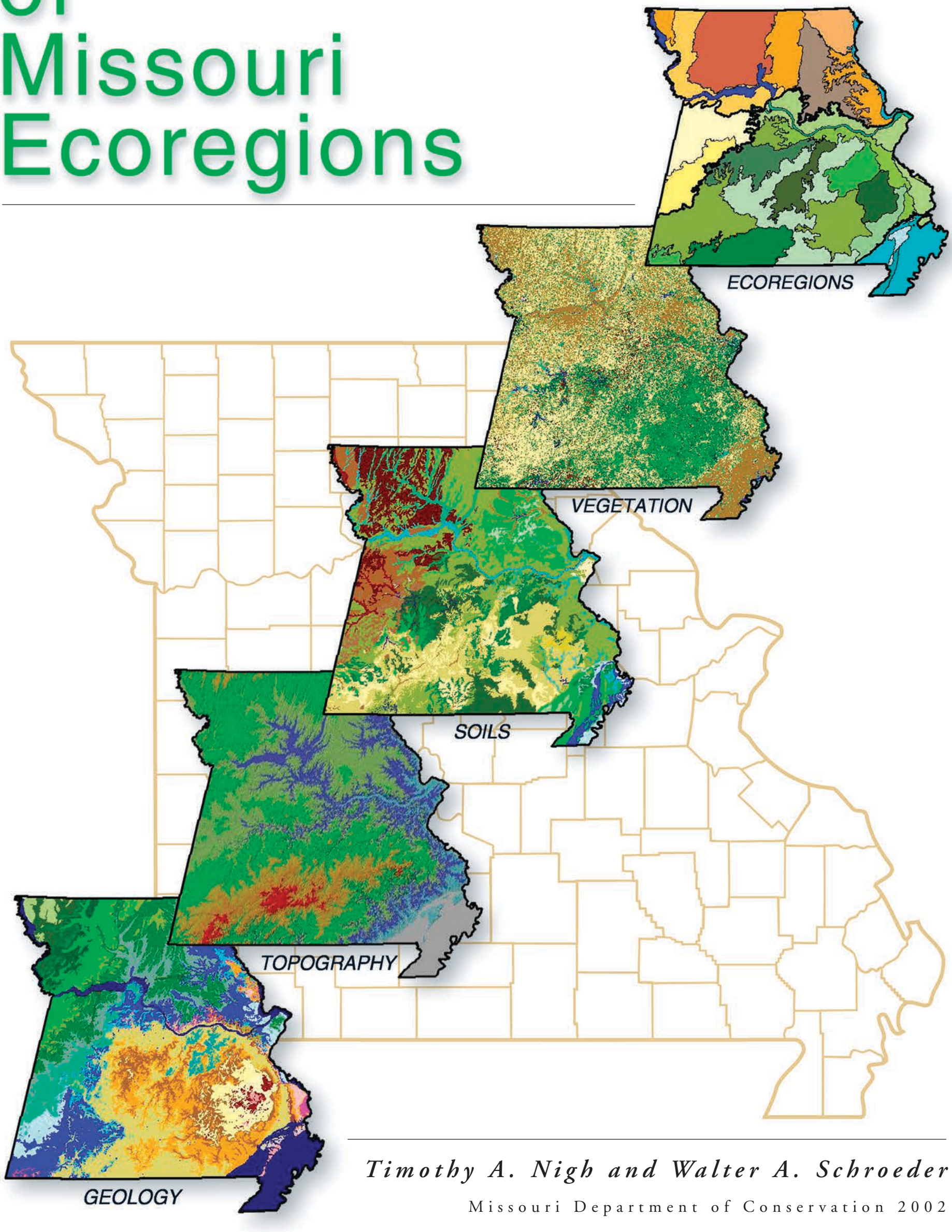
Atlas of Missouri Ecoregions



Timothy A. Nigh and Walter A. Schroeder

Missouri Department of Conservation 2002

Atlas of Missouri Ecoregions

Timothy A. Nigh
Walter A. Schroeder

Missouri Department of Conservation 2002

Abstract

The conservation of Missouri's rich array of native plant and animal species will require the maintenance and enhancement of the native ecosystems they depend on. Regional and landscape ecosystems for Missouri have been derived using the United States Forest Service approach to ecological classification.

An ecological classification system (ECS) is a framework that allows natural resource managers to identify, describe, and map units of land with similar physical and biological characteristics at scales suitable for natural resources planning and management. Once in place, an ECS serves as a basis for an inventory of the number, size, location, and status of native ecosystems. An ECS allows planners and managers to assess the capability of land to produce resources and respond to management. An ECS is also a common communication tool for considering the conservation of multiple resource values.

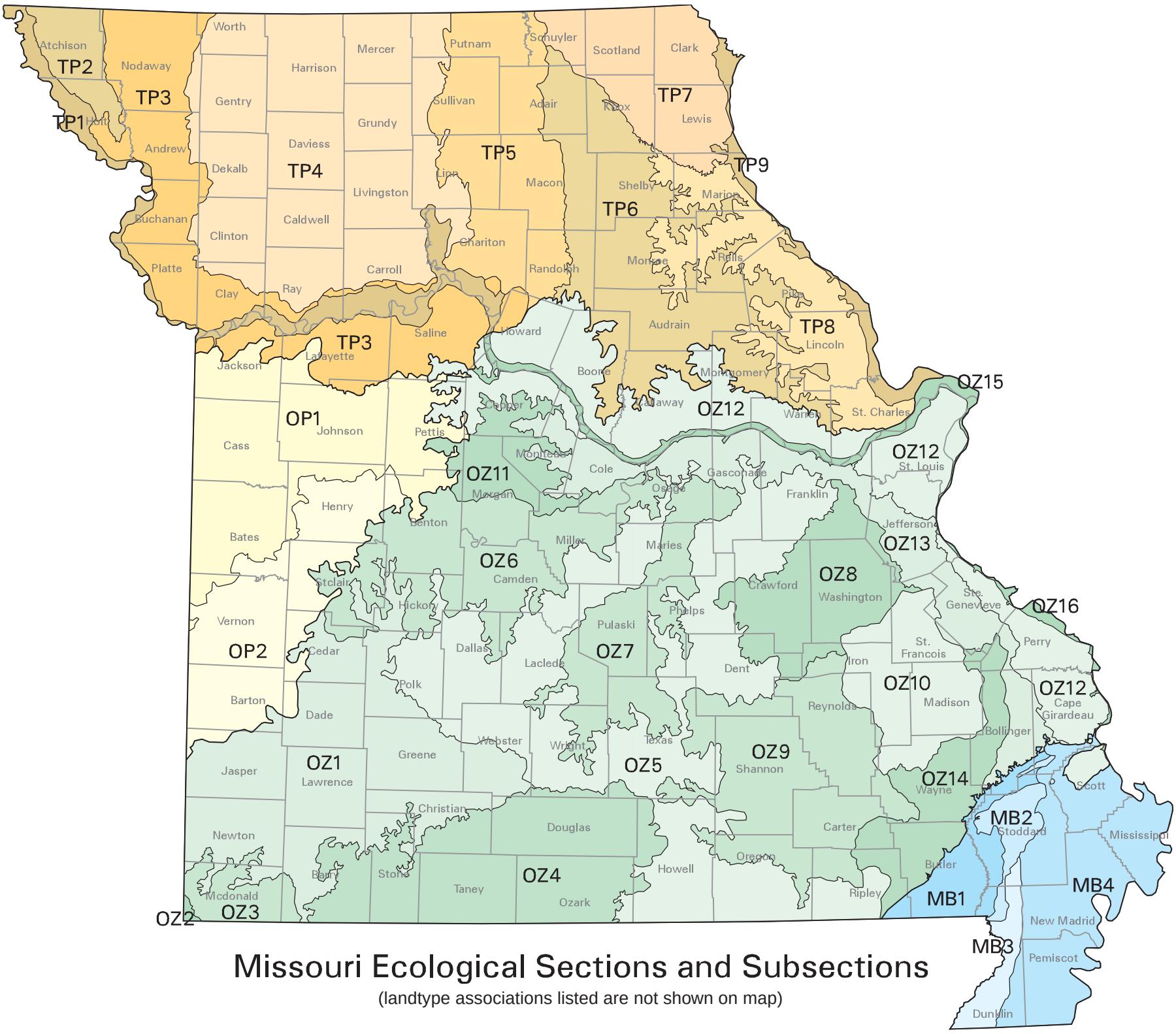
The Missouri Ecological Classification Project has been working to apply the USFS National Hierarchical Framework of Ecological Units toward ecological classification of lands in Missouri. Under this framework, attributes of climate, landforms, geology, hydrology, soils, and vegetation patterns are utilized at various scales to divide the earth's surface into progressively finer ecological units. The influence of each of these attributes varies, depending upon the scale of application and local significance of a factor. The spatial hierarchy of this system enables users to address resource management issues at national, regional, landscape, or local scales. This enhances our ability to nest local resource management objectives into larger contexts, so that local accomplishments contribute to the overall condition of the landscape or ecoregion.

The Missouri ECS Project has participated in the national effort to develop ecological units through the Subsection level. Landtype Associations have been developed and mapped for Missouri through a locally coordinated effort. Ecological Landtypes (ELTs) and ELT-Phases (ELT-Ps) have been developed for the Current River Hills Subsection by intensive field sampling and analysis.

The purpose of this atlas is to provide maps and descriptions of the 4 ecological Sections, 31 Subsections, and 264 Landtype Associations for Missouri. The atlas is intended to serve as a tool for understanding these ecosystems and as an ecological framework for natural resources inventory, planning, and management.

Contents

List of Regions



Missouri Ecological Sections and Subsections

(landtype associations listed are not shown on map)

List of Maps

Foreword

In 1995, the Missouri Resource Assessment Partnership (MoRAP) endorsed a proposal to develop an ecological classification system (ECS) for Missouri. The ECS provides an effective framework for natural resources inventory, planning, and management. The MoRAP partners have developed a number of digital data layers over the past six years that are needed to pursue an ECS and to provide for practical applications. Over the past several years, the ECS, in combination with other newly developed data layers, has been effectively applied to regional assessment and planning.

Development of the system truly has been a team effort. We are excited to finally have this atlas documenting and describing the system within Missouri. In addition to the printed atlas, a CD-ROM containing text and map plates, digital coverages, and attribute databases is available.

We are indebted to Dr. Walter Schroeder, Tim Nigh, and their numerous colleagues for many hours of effort that have resulted in this outstanding product: an easily accessible system that will continue to enhance our ability to view and manage resources more holistically at regional and landscape scales.

David D. Diamond
MoRAP Director

Kari J. Craun, USGS
MoRAP Steering Committee Chair

MoRAP Partners

American Bird Conservancy

James River Basin Partnership

Missouri Department of Conservation

Missouri Army National Guard

Missouri Department of Natural Resources

Missouri Department of Transportation

Ozark National Scenic Riverways

U.S. Environmental Protection Agency

USDA/FS Mark Twain National Forest

USDA Natural Resources Conservation Service

United States Fish and Wildlife Service

USGS Columbia Environmental Research Center

USGS Missouri Cooperative Fish and Wildlife Research Unit

USGS Mid-Continent Mapping Center

University of Missouri–Columbia

World Wildlife Fund

Acknowledgments

The Missouri Ecological Classification System Project is an interagency-sponsored project conducted under the auspices of the Missouri Resource Assessment Partnership (MoRAP). While funding was provided by the Missouri Department of Conservation, USDA North Central Forest Experiment Station, and the Mark Twain National Forest, contributions of staff and in-kind services was provided by all of the MoRAP partners. MoRAP acted diligently as the project administrator and the forum for interagency coordination.

Development and applications of multiple digitally accessible, spatial data layers were supported by five Geographic Information System labs. The Geographic Resources Center (University of Missouri–Columbia [UMC] Department of Geography), along with James Harlan and Timothy Haithcoat, supported early efforts to map sections and subsections for the national effort. David Diamond and Diane True from MoRAP provided invaluable information and advice throughout the duration of this project. The Missouri Department of Conservation GIS lab, along with Tony Spicci and Kevin Borisenko, were consistently supportive in providing data layers and technical advice. The Center for Agricultural Research and Environmental Sciences (CARES at UMC) and their staff members Chris Barnett and Bryan Mayhan provided valuable digital soils information. Finally, the ECS project shared a GIS lab with the USGS-Northern Prairie Research Center on the UMC campus. Fred Young and Bill Pauls from the National Resources Conservation Service wrote the soil descriptions. **John Krstansky** provided all GIS and cartographic support throughout the mapping of Landtype Associations and the production of the atlas.

Development and mapping of ecological units was overseen by an interagency project team. Core team members participated consistently throughout the process, while extended team members were consulted as needed. Together these people provided the expertise and camaraderie to make this project possible. They are listed below.

Development of the *Atlas of Missouri Ecoregions* has been a team effort. A hearty thanks to all those who have participated. The atlas is something we can all be proud of.

Core ECS Team

Timothy A. Nigh
(Missouri Department of Conservation)

Walter A. Schroeder
(University of Missouri–Columbia, Department of Geography)

John Krstansky
(University of Missouri–Columbia)

Lynda Richards
(Mark Twain National Forest)

Dennis Potter
(National Resources Conservation Service)

Extended ECS Team

Steve Westin
(Missouri Department of Conservation)

Larry Houf
(Missouri Department of Conservation)

John Kabrick
(Missouri Department of Conservation)

Mike Shanta
(Mark Twain National Forest)

Garry Houf
(Mark Twain National Forest)

Sybil Amelon
(Mark Twain National Forest)

Paul Johnson
(North Central Forest Experiment Station)

Fred Young
(National Resources Conservation Service)

Don Vogt
(National Resources Conservation Service)

Terry Barney
(National Resources Conservation Service)

Dennis Meinert
(Missouri Department of Natural Resources)

Dean Martin
(Missouri Department of Natural Resources)

Gary Frazier
(United States Fish and Wildlife Service)

Charles Putnam
(Ozark National Scenic Riverways)

Douglas Ladd
(The Nature Conservancy)

David Diamond
(Missouri Resource Assessment Partnership)

Introduction

PURPOSE

Missouri is a beautiful and diverse state. Located near the center of the North American continent at the confluence of our nation's largest rivers, Missouri is home to more than five thousand species of plants and more than twenty thousand animals. Missouri's biodiversity contains representatives from adjacent biomes, as well as species found only here. Conservation of our native flora and fauna will require the maintenance and restoration of the native ecosystems that support them.

In order to conserve our natural heritage and accommodate the diversity of demands being placed on our natural resources, natural resource planning and management is shifting from an emphasis on individual species or products toward the management of entire ecosystems. An ecosystem—defined simply as a community of living organisms interacting with each other and the physical environment—is a level that allows humans to more easily recognize the interrelationships between individual physical and biological resources, integrate their individual viewpoints and needs, and predict the capability of a unit of land to provide a variety of compatible outputs.

The purpose of this atlas is to provide a framework for recognizing Missouri's ecosystems at regional and landscape scales. It provides maps and descriptions of useful and functional units of land that have characteristic patterns in their biological and physical attributes. We hope this system will become a common communication tool that facilitates planning, management, and research at an ecosystem level. Carry this atlas with you as you travel, and use it to gain a better understanding and a *sense of place* about the territory you live in.

CONCEPTUAL APPROACH

For centuries, geographers worked with the idea that the earth's surface could be divided into natural regions having similar environmental characteristics throughout. It is now widely recognized that clearly defined natural or ecological regions do not inherently exist. Rather they are constructs of the human mind that await to be discovered, described, analyzed, and mapped according to the purposes and criteria we define. Numerous divisions and maps of the earth's surface have been constructed using only one or a few environmental components. Thus, there are maps of soil regions, physiographic regions, climate regions, lithologic regions, tectonic regions, biogeographic regions, plant (phytogeographic) regions, and animal (zoogeographic) regions.

More recently, the desire to take a more holistic or ecological approach to natural resource management has led to the development of multifactor land classification systems that attempt to integrate numerous physical and biological components into the recognition and mapping of natural or ecological regions. These efforts have been enhanced by the advent of Geographic Information Systems (GIS) that allow us to view and integrate any number of layers or maps. Despite the utility of this technology, natural or ecological regions remain a human construct, and no single, universal set of natural or ecological regions will satisfy all purposes.

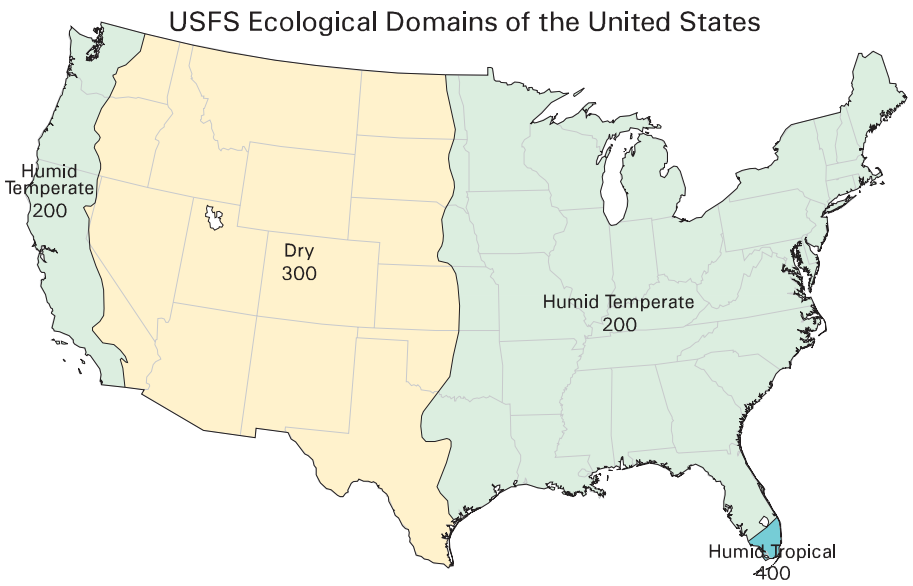
With these caveats in mind and after careful consideration of numerous alternatives, a working group with members from numerous state, federal, and private natural resource organizations determined that application of the USFS National Hierarchical Framework of Ecological Units (Avers et al., 1994) toward the identification and mapping of ecological units of land in Missouri would be valuable (Nigh and Amelon, 1995). This ecological classification system (ECS) is spatially hierarchical; that is, it breaks the land into a nested system of units from broad ecoregions to subregions, through landscapes to local sites. Thus an ECS facilitates planning and management at multiple spatial scales from regional through local to the individual project level. In addition, ecological units in Missouri are nested into a *national* land classification system. Being part of a national system gives Missouri a broader ecological context and fosters communication with federal agencies and adjacent states. The system integrates a wide variety of physical and biological factors into the identification of ecological units and identifies major differentiating criteria for delineation of units at all levels in the hierarchy. Consequently, multiple ecosystem components are integrated into a single system, and consistent standards exist for application of ECS across all states. These criteria are applied to the development of a mappable framework of land units. These maps and their descriptions are tools for identifying and prioritizing natural resource outputs most suitable for a given land unit and help land managers predict outcomes of various management practices. Additionally, the system is designed to be dynamic and flexible, so that it can change as new information becomes available and users of the system provide feedback. Thus, this is the first approximation of a system that will evolve through time.

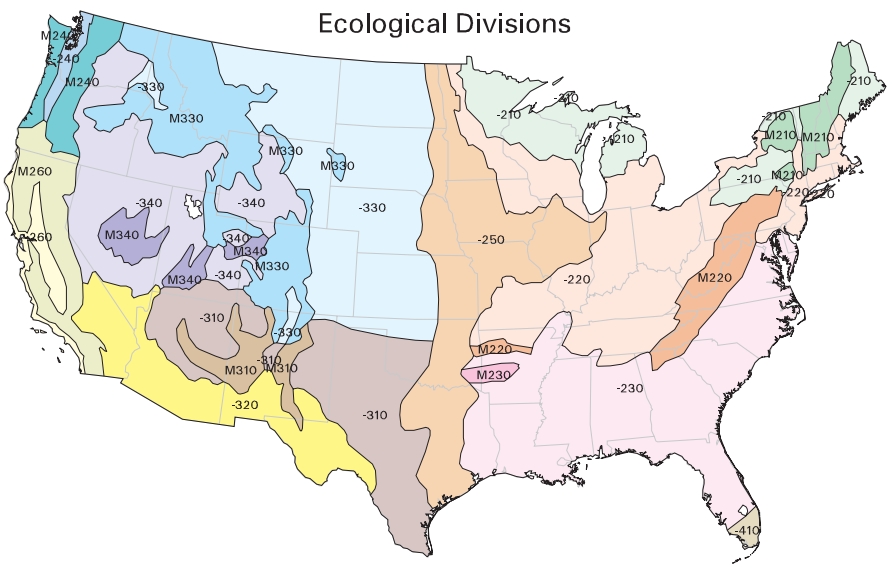
THE USDA FOREST SERVICE HIERARCHY OF ECOLOGICAL UNITS

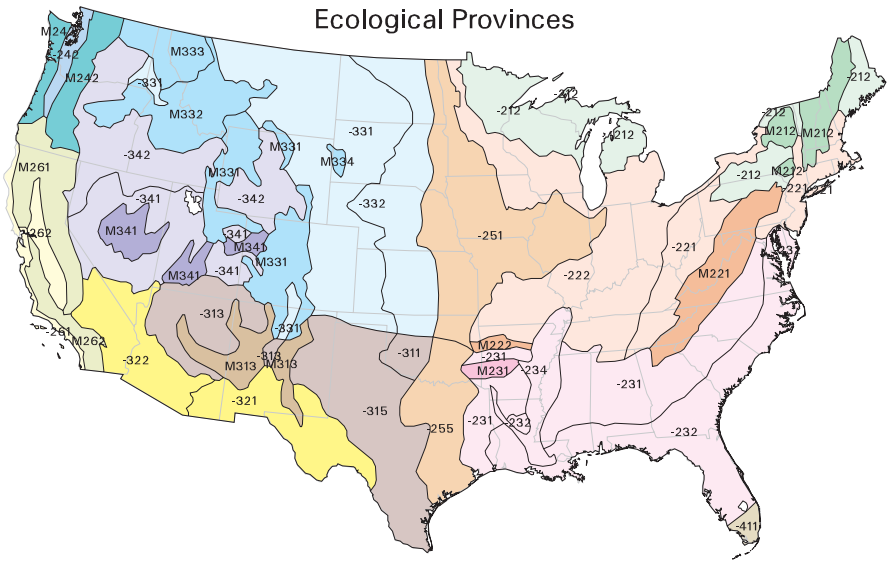
The national framework consists of a nested hierarchy of eight levels of classification and geographic generalization. At the higher, most generalized levels, conti-

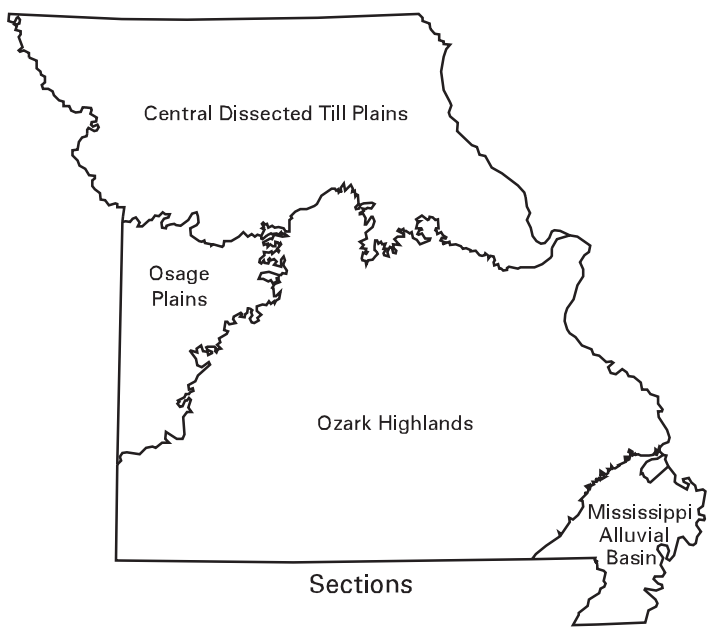
TABLE 1. NATIONAL HIERARCHICAL FRAMEWORK FOR ECOLOGICAL CLASSIFICATION (Avers et al., 1993) AND APPLICATION TO MISSOURI

Scale	Ecological Units	Size	Major Differentiating Criteria	Example Missouri and Current RiverHills Types
Ecoregion	Domain	Subcontinental 1,000,000 sq. mi.	Continental and Regional Climate Zones Broad Soil and Vegetation Lifeform patterns	Humid Temperature Domain
	Division	Multiple State 100,000 sq. mi.		Hot Continental Division
	Province	Multiple State 10,000 sq. mi.		Eastern Broadleaf Forest Province
Subregion	Section	Regions 1000 sq. mi.	Regional and Subregional Ppt. and Temp. Geomorphology Major Soil Great Groups Potential Vegetation Formations	Ozark Highlands Section
	Subsection	Subregions 10-100s sq. mi.		Current River Hills Subsection
Landscape	Landtype Association (LTA)	Landscape 1000s acres to 10s sq. mi.	Local Climate Landform/Topography Geologic Parent Materials Soil Associations Potential Vegetation Alliances	Current and Black River Breaks LTAs Jacks Fork and Eleven Point Breaks LTAs Current–Eleven Point Dissected Plains LTA Eminence Igneous Knobs LTA
Land Unit	Landtype (ELT)	Site 1–100s acres	Landform/Topographic Position Geologic Parent Materials Soil Series Potential Vegetation Association	Roubidoux/Upper Gasconade Summits ELT Lower Gasconade Bench ELT Active River Channel ELT
	Landtype Phase (ELT-P)	Site <100 acres		Rocky, Ultic RO/UG Summits ELT-P Ultic Lower Gasconade Bench ELT-P Barren/Herb Gravel Bar ELT-P









nental climate, broad patterns of soils, and natural vegetation are most important in differentiating *domains, divisions,* and *provinces.* At intermediate levels, lithology, topography, geomorphology, regional soils, and regional potential vegetation are most important in delineating *sections* and *subsections.* At the lower levels, the most important factors are local variations in topography, parent materials, soil types, and vegetation communities, which define *landscapes* and *site-specific levels.* Thus, the problem of how to weight the various components of the environment is addressed by bringing in different ones at different levels of the hierarchy. A more complete discussion of the system is in the National Hierarchical Framework of Ecological Units (Avers et al., 1994).

The classification system has both a terminology and a numerical code for each unit. The terminology reflects what the distinguishing criteria are for that level. For example, at the province level, "Eastern Broadleaf Forest (Continental)" indicates geographic location, climate, and broad vegetation formations as criteria. At the section and subsection levels, terminology consists of a geographical identifier ("Current River") and a topographic descriptor ("Hills"). At the landtype association level, terminology consists of a geographical identifier ("Current and Black River"), a vegetation descriptor ("Oak Forest"), and a topographic descriptor ("Breaks").

The highest levels of the system—*domain, division,* and *province*—are levels of great generalization useful for national planning and assessment. All of Missouri lies within the *Humid Temperate Domain* (code number 200). Missouri includes portions of three *divisions: Hot Continental* (220), *Subtropical* (230), and *Prairie* (250). Each of these three divisions is represented in Missouri by a single *Province,* respectively, *Eastern Broadleaf Forest (continental)* (222), *Lower Mississippi Riverine Forest* (234), and *Prairie Parkland (Temperate)* (251). The three highest units were determined at the national level with national perspectives.

The intermediate levels of the classification system are the *section* and *subsection.* They are useful for statewide and regional assessment and planning. These units were determined by persons working at the state level, in cooperation with their counterparts in adjacent states. Missouri has four *sections* that have been recognized as distinct biogeographic regions for over a century. They are the *Ozark Highlands* (222A), *Mississippi Alluvial Basin* (234A), *Central Dissected Till Plains* (251C), and *Osage Plains* (251E). Criteria used to establish sections are geomorphology (land

200 HUMID TEMPERATE DOMAIN

-210 Warm Continental Division
-212 Laurentian Mixed Forest Province

M210 Warm Continental Regime Mountains
M212 Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province

-220 Hot Continental Division
-221 Eastern Broadleaf Forest (Oceanic) Province
-222 Eastern Broadleaf Forest (Continental) Province

M220 Hot Continental Regime Mountains
M221 Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow Province
M222 Ozark Broadleaf Forest - Meadow Province

-230 Subtropical Division
-231 Southeastern Mixed Forest Province
-232 Outer Coastal Plain Mixed Forest Province
-234 Lower Mississippi Riverine Forest Province

M230 Subtropical Regime Mountains
M231 Ouachita Mixed Forest - Meadow Province

-240 Marine Division
-242 Pacific Lowland Mixed Forest Province

M240 Marine Regime Mountains Redwood Forest Division
M242 Cascade Mixed Forest-Coniferous Forest-Alpine Meadow Province

-250 Prairie Division
-251 Prairie Parkland (Temperate) Province
-255 Prairie Parkland (Subtropical) Province

-260 Mediterranean Division
-261 California Coastal Chapparral Forest and Shrub Province
-262 California Dry Steppe Province

M260 Mediterranean Regime Mountains
M261 Sierran Steppe-Mixed Forest-Coniferous Forest-Alpine Meadow Province
M262 California Coastal Range Open Woodland-Shrub-Coniferous Forest-Meadow Province

300 DRY DOMAIN

-310 Tropical/Subtropical Steppe Division
-311 Great Plains Steppe and Shrub Province
-313 Colorado Plateau Semi-Desert Province
-315 Southwest Plateau and Plains Dry Steppe and Shrub Province

M310 Tropical/Subtropical Regime Mountains
M313 Arizona-New Mexico Mountains Semi-Desert-Open Woodland-Coniferous Forest-Alpine Meadow Province

-320 Tropical/Subtropical Desert Division
-321 Chihuahuan Semi-Desert Province
-322 American Semi-Desert and Desert Province

-330 Temperate Steppe Division
-331 Great Plains-Palouse Dry Steppe Province
-332 Great Plains Steppe Province

M330 Temperate Steppe Regime Mountains
M331 Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province
M332 Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow Province
M333 Northern Rocky Mountain Forest-Steppe-Coniferous Forest-Alpine Meadow Province
M334 Black Hills Coniferous Forest Province

-340 Temperate Desert Division
-341 Intermountain Semi-Desert and Desert Province
-342 Intermountain Semi-Desert Province

M340 Temperate Desert Regime Mountains
M341 Nevada-Utah Mountains-Semi-Desert-Coniferous Forest-Alpine Meadow Province

400 HUMID TROPICAL DOMAIN

-410 Savanna Division
-411 Everglades Province

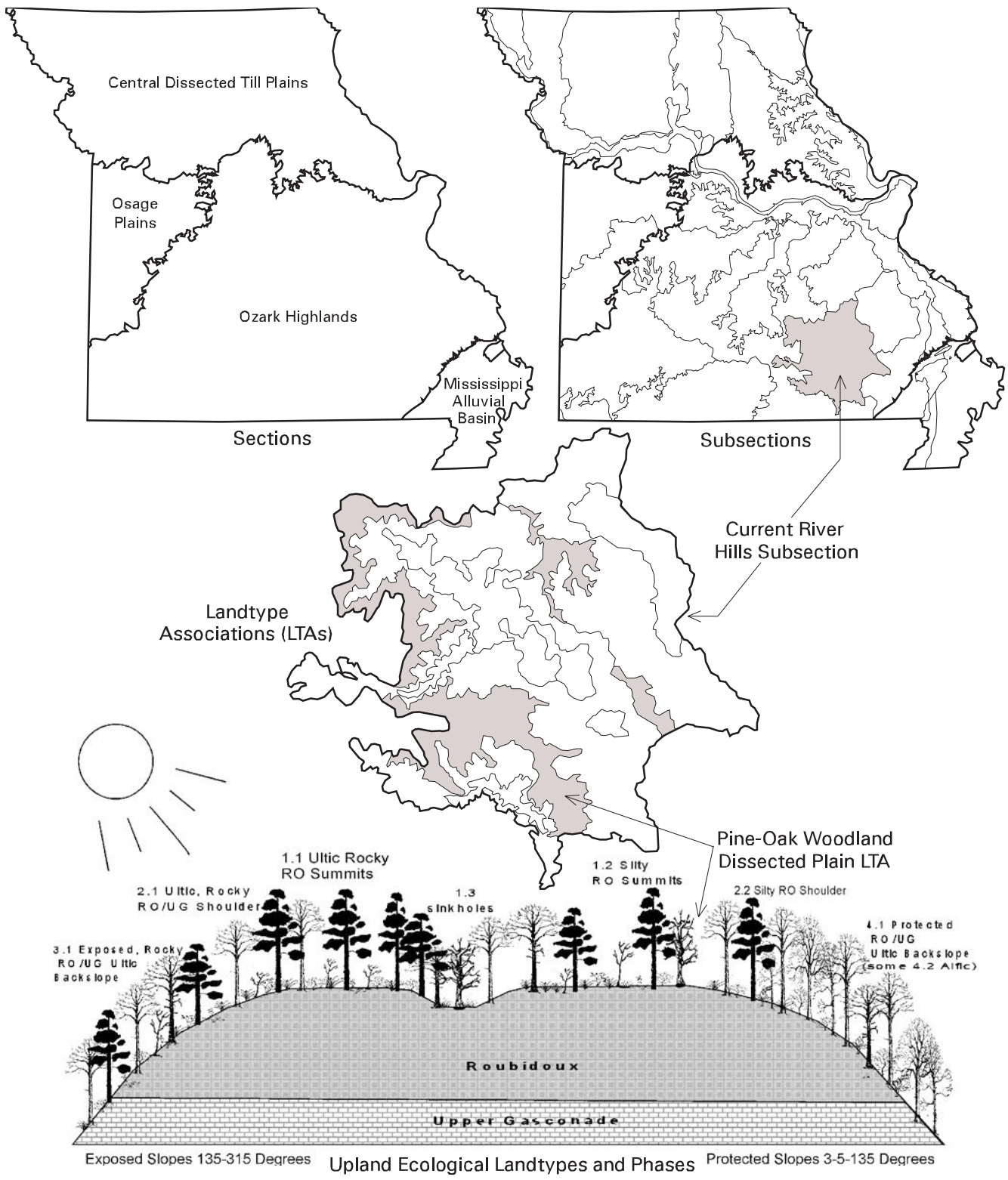
USFS Ecological Domains, Divisions, and Provinces

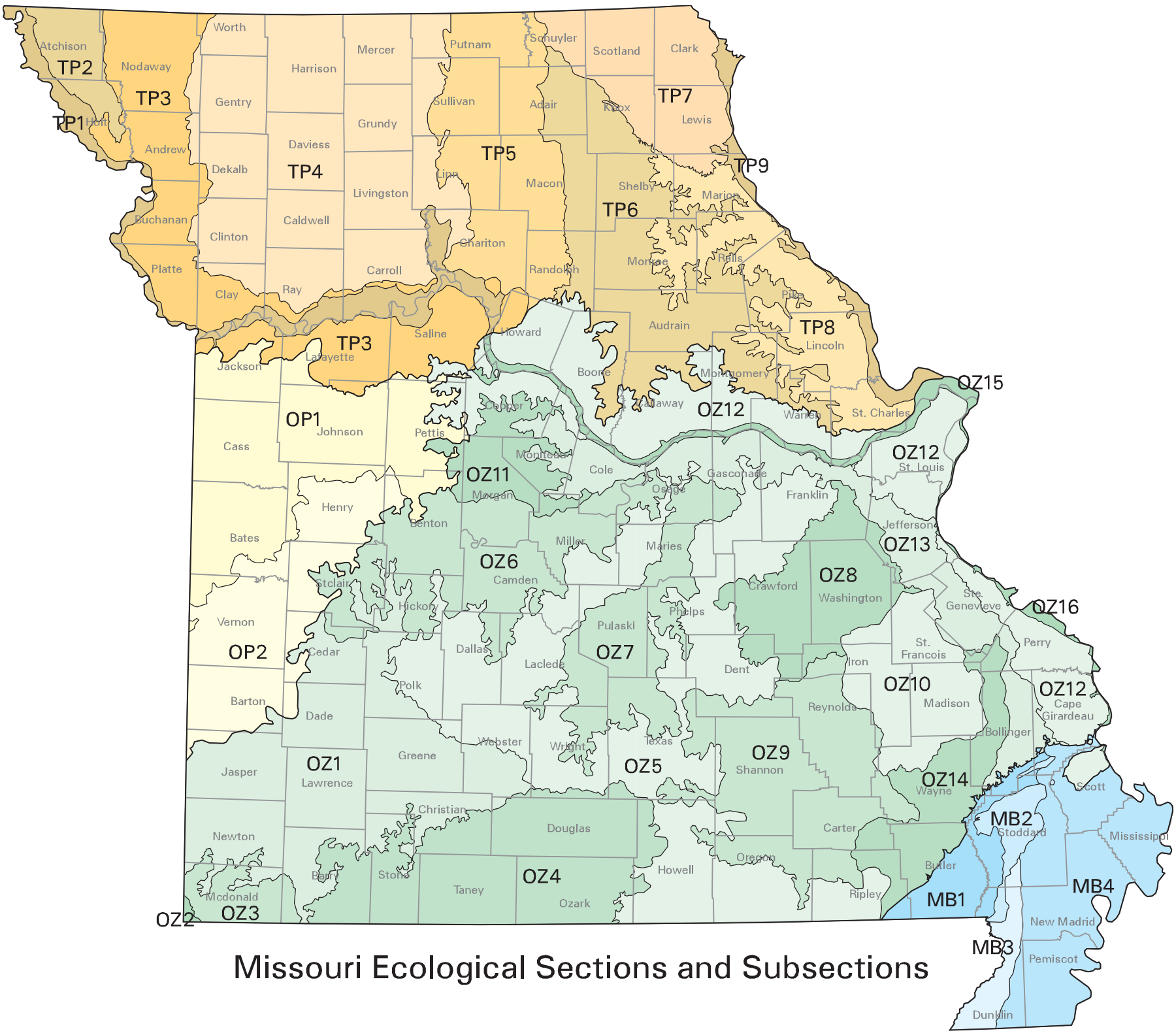
form, relative relief, lithology, structure, and geomorphic process), potential vegetation, and major soil groups. *Sections* are subdivided into *subsections,* which average approximately 2,000–3,000 square miles or from three to five counties in Missouri. There are a total of thirty-one subsections in Missouri, of which the Ozark Highlands section accounts for sixteen. Some of these subsections primarily lie in adjacent states, with only small portions of them extending into Missouri. In general, the same criteria that are used to establish sections are used to establish subsections, although at a higher resolution *(see map on page 4)*.

The lower levels of the hierarchical classification consist of the landtype association (LTA), ecological landtype (ELT), and ecological landtype phase (ELT-P). These levels are appropriate for local planning and assessment, such as watersheds, counties, ranger districts, conservation areas, and even site and landownership tract planning. LTAs and ELTs are based on more local patterns in topography, geologic parent materials, soil types, and vegetation communities. The distinctive character of the LTAs influences the distribution of natural resources, and thus the management challenges and opportunities, at a landscape scale. While LTAs are from tens to hundreds of square miles in size, the lowest level, ELT-P, identifies ecosystem units as small as a few acres. They have relevance at a site or stand level. As of 2002, mapping of LTAs has been completed for Missouri and is introduced in this atlas. However, only small portions of the state have been classified and mapped at the ELT and ELT-P levels. State and federal agencies can provide the reader with updated information on the status of classification and mapping of these levels in Missouri.

The numerical code developed for the national framework has been replaced by a code more suitable for Missouri. This makes it possible to use letters for sections (OZ), numbers for subsections (OZ1), and small letters for LTAs (OZ1a) for easier communication and map labeling of the units relevant to our state.

While the rationale and structure of the framework is unlikely to change in the foreseeable future, the identification of specific units and their boundaries certainly will. The hierarchical system has been built from the top down, a procedure necessitated by the lack of detailed information and understanding at local levels. As more information becomes available at lower levels, modifications may have to be made at progressively higher levels. This is most clearly seen with boundaries. The more generalized boundaries drawn at the subsection level on the basis of more geographically generalized information will have to be refined as more detailed mapping is done at the LTA and lower levels. Higher-resolution classification and mapping will help make the earlier boundaries, drawn with lower-resolution information, factually more accurate and geographically more precise.





Missouri Ecological Sections and Subsections

MB Mississippi River Alluvial Basin Section

MB1 Black River Alluvial Plain Subsection
MB2 Crowley's Ridge Subsection
MB3 St. Francis River Alluvial Plain Subsection
MB4 Mississippi River Alluvial Plain Subsection

OP Osage Plains Section

OP1 Scarped Osage Plains Subsection
OP2 Cherokee Plains Subsection

OZ Ozark Highlands Section

OZ1 Springfield Plain Subsection
OZ2 Springfield Plateau Subsection
OZ3 Elk River Hills Subsection
OZ4 White River Hills Subsection
OZ5 Central Plateau Subsection
OZ6 Osage River Hills Subsection
OZ7 Gasconade River Hills Subsection
OZ8 Meramec River Hills Subsection
OZ9 Current River Hills Subsection
OZ10 St. Francois Knobs and Basins Subsection
OZ11 Prairie Ozark Border Subsection
OZ12 Outer Ozark Border Subsection
OZ13 Inner Ozark Border Subsection
OZ14 Black River Ozark Border Subsection
OZ15 Missouri River Alluvial Plain Subsection
OZ16 Mississippi River Alluvial Plain Subsection

TP Central Dissected Till Plains Section

TP1 Missouri River Alluvial Plain Subsection
TP2 Deep Loess Hills Subsection
TP3 Loess Hills Subsection
TP4 Grand River Hills Subsection
TP5 Chariton River Hills Subsection
TP6 Claypan Till Plains Subsection
TP7 Wyaconda River Dissected Till Plains Subsection
TP8 Mississippi River Hills Subsection
TP9 Mississippi River Alluvial Plain Subsection

RELATIONSHIPS TO OTHER NATURAL OR REGIONAL ECOSYSTEM MAPS

The Natural Divisions of Missouri. In 1980, Thom and Wilson established the Natural Divisions of Missouri in order to give guidance and statewide geographic coherence to the protection of designated Natural Areas and listed Rare or Endangered Species. The system has gained widespread use over the past two decades. While similar to the Missouri ECS, there are some important differences.

The Thom and Wilson system preserved the four major "natural divisions" of Missouri that had been recognized since the nineteenth century: the Ozarks, the Glaciated Plains, the unglaciated Osage Plains, and the southeastern Mississippi Lowlands. These four regions are largely determined by landform (topography), rock type (lithology), and surface material. A new concept for natural regions in Missouri that Thom and Wilson introduced was the separation of the channels and alluvial plains of the Mississippi and Missouri Rivers into their own natural division, the Big Rivers. They also pulled the Ozark Border Division out as distinct from the Ozarks. The subdivision of these divisions into eighteen sections is heavily influenced by drainage basins; many section boundaries are drawn along drainage divides. Thus, the hydrologic organization of the landscape is important in the determination of this early set of natural regions. The text that accompanies the map, which presents the rationale and distinguishing characteristics of each division, is heavily weighted in terms of distinctive plant, animal, and fish species, and natural communities, which reflects the perspectives of the authors and the ultimate use of the system in protection of natural areas and rare species.

Many of the sections in Thom and Wilson are the same in concept to the subsections in this ECS. Some differences are related to our current ability to add precision to a boundary using GIS technology. Other differences between Thom and Wilson's sections and the current ECS subsections are based mainly on our reliance on topography, geology, soil, and vegetation patterns, rather than watersheds, in their delineation. This is true especially in the Ozarks, where the recognition of the Central Plateau Subsection encompasses many watershed divides. Finally, the natural divisions and their sections stop at the Missouri state line, with no formal linkages established outside of the state.

The Ecological Classification System of the Environmental Protection Agency. A separate ecological classification and mapping system has been developed under the aegis of the Environmental Protection Agency (EPA) (Omernik, 1987; Omernik, 1995). It has also been developed with national standards and a uniform procedure for all states, and it is also hierarchical with four levels of generalization. EPA Ecoregions are also relevant to integrated ecosystem management, but more specifically they help in the development of biological criteria and water quality standards and management goals for non-point-source pollution (Chapman et al., 2002). The EPA approach to identification of ecological regions is to analyze patterns of biotic and abiotic components (geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology) that reflect differences in ecosystem quality and integrity. However, instead of the various components being weighted differently at the various levels of the hierarchy, in the EPA system the relative importance of each component varies from one ecological region to another regardless of the hierarchical level. That is, the most distinguishing features of each ecosystem are identified at each level of the hierarchy (Omernik 1995; Griffith et al., 1994). The ecological classification and mapping units developed by the EPA system for Missouri were published in 2002 as a map at 1:1,800,000 and an accompanying table of characteristics (Chapman et al., 2002). Participation by members of the Missouri ECS team in this effort resulted in most of the level IV units of the EPA system being coincident with subsections of the Missouri ECS. However, Level III units are substantially different than USFS sections. Many of the differences appear to be related to a heavy reliance on current land-cover patterns by the EPA mappers.

The Ecological Land Classification System of the Mark Twain National Forest. Miller (1979) developed a classification system of Mark Twain National Forest (MTNF) lands based on the USDA Forest Service Hierarchy. Sections and subsections followed Thom and Wilson (1981) and did not link to adjacent states. LTAs and ELTs were developed for MTNF lands only. Consequently, these units were derived by looking only at the range of character of lands within their ownership. This resulted in somewhat different criteria for mapping LTAs, and thus some differences with statewide LTAs are seen. For example, because MTNF lands do not occupy the steepest lands on the Current or Black Rivers, they miss the extreme "breaks" landform. Therefore their "breaks" are similar to "hills" in the Missouri ECS where breaks are delineated for the most rugged lands only. ELTs were developed with a different set of landforms and relied heavily on soil maps and subjective application of vegetation classification. The Missouri ECS pilot ELTs that were developed for the Current River Hills Subsection relied on field sampling of soil and vegetation data among different landforms and geologic parent materials, resulting in tighter biophysical relationships that are able to be modeled in GIS. Despite these differences, the MTNF system has had a history of effective application on the forest. One might consider the Missouri ECS as a statewide extension of the earlier MTNF effort. It is hoped that the Missouri ECS will provide a broader context for MTNF lands.

METHODS OF DETERMINING MISSOURI SECTIONS, SUBSECTIONS, AND LANDTYPE ASSOCIATIONS

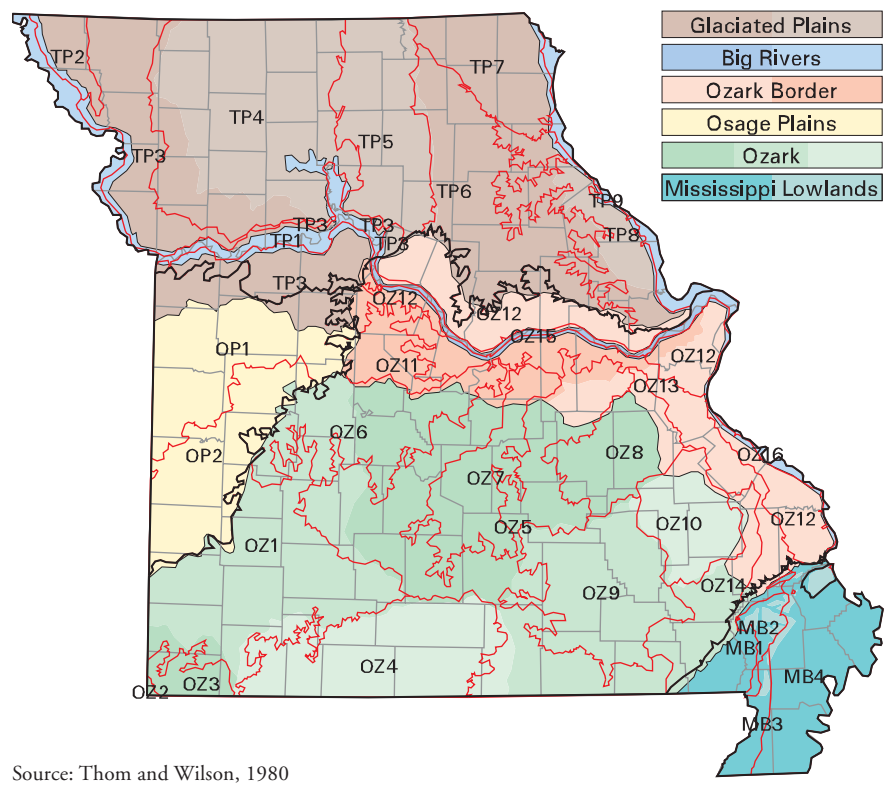
At the beginning of the Missouri ECS Project, an interagency team with experts from most state, federal, and private natural resource organizations was assembled to oversee the project and periodically review products. In addition to principal, core members, many other specialists were consulted as needed in the process. The Missouri sections and subsections were determined and mapped by the interagency ECS Team during 1993–1994. During this process and later we consulted with adjacent states and coordinated cross-state boundary matching. We also reviewed the ecoregions developed in other states (Foti, 1974; Schwegman, n.d.; Pell, 1983; Prior, 1991; Griffith et al., 1994; Hole, 1994; Woods and Omernik, 1996; Griffith et al., 1998; Pater et al., 1998; Bryce et al., 1998; Woods et al., 1999; Chapman et al., 2000; and Omernik et al., 2000). Printed maps, digital coverages, and descriptive information were provided to the USDA Forest Service Eastern Region ECOMAP Team for inclusion in two national publications and a CD-ROM (McNabb and Avers, 1994; Keys et al., 1995).

The LTAs were mapped systematically, subsection by subsection, during 1995–1998. Only Missouri portions of each subsection were considered for this mapping effort. Because we used some higher-resolution source data for the LTA mapping, subsection boundaries were refined by this process. In addition, several changes not reflected in the national subsection documentation were created during LTA mapping. These were passed along to the national effort for future revisions.

Throughout the process, we used published and unpublished maps and other references listed in the bibliography, consulted with others knowledgeable about specific topics and regions of the state, and benefited from several decades of fieldwork and personal knowledge with the physiography and biogeography of the state.

We worked under guidelines issued by the Forest Service for the establishment of sections, subsections, and LTAs in all states. Among these guidelines were considerations of reasonable compactness and contiguity of mapped areas and maximum and minimum areal limitations (not too large, not too small). Guidelines directed that sections and subsections should be based primarily on physical characteristics (lithology, relief, slope, elevation, and geomorphic process), potential natural vegetation, and soils. All other environmental components could be considered where appropriate. Different components were used as the distinguishing characteristic in some subsections and LTAs. For example, surficial material (loess) and soils took primacy in identifying the subsections of northwestern Missouri, karst distinguishes several Ozark subsections and LTAs, and fluvial processes distinguish the Missouri and Mississippi River subsections. Finally, we retained long-established regions and their terminology, where appropriate, to avoid creating radically different regions and boundaries and introducing terminology that differed from that used vernacularly in Missouri. The guidelines also recommended a topical outline for the nomenclature of subsections and LTAs, which we followed.

Natural Divisions, Sections,
and Ecological subsections of Missouri



Source: Thom and Wilson, 1980

The mapping process was an iterative one of visual integration of numerous physical and biological maps, along with expert input from written and verbal sources. We often started with existing regionalizations of the state, especially Schroeder Landform Regions (in progress) and a Missouri General Soils Map (Allgood and Persinger, 1979), and digital elevation models as a way of initiating our understanding of the physical setting of potential ecoregions. Often, obvious differences in landforms would be related to coarse patterns in geology and soils, leading to an initial set of lines. These lines were then superimposed on other layers, such as higher resolution soils, topography, and historic and current vegetation, and adjusted accordingly. Map units were then digitized and printed on top of relevant diagnostic layers for review by team members. Subsection mapping was done at 1:500,000 with contours from USGS quadrangles at 1:250,000 as a backdrop. LTA mapping was done at 1:100,000 with contours from USGS quadrangles at 1:100,000 as a locational backdrop. All line work was evaluated by team members as the iterative process proceeded until consensus was reached. For LTAs, ground and aerial field reconnaissance, as well as consultation with local experts, was carried out to further evaluate and adjust the lines.

Principal maps included landform regions (Schroeder, n.d.; McBride, 1977), land-resource regions (USDA-SCS, 1981), digital elevation models (60m DEMs derived from 1:100,000 USGS contours), topographic quadrangles (1:250,000 and 1:100,000), bedrock geology (Anderson, 1979; Pratt et al., 1992; and Hall, 1963), soils (Krusekopf, 1966; Allgood and Persinger, 1979; Scrivner et al., 1975; and USDA-STATSGO, 1994), surficial geology (Whitfield, 1982), potential natural vegetation (Küchler, 1964, 1985), presettlement prairie (Schroeder 1981a, 1981b), forest cover (Giessman et al., 1986), and current land cover (MoRAP Land Cover Project). Individual county soil surveys, while not digital, were important in LTA delineation. Other map sources used in delineations and interpretations included quaternary geology (Richmond and Fullerton, 1991; Richmond et al., 1991; and Richmond and Weide, 1993), karst and losing streams (Schroeder, 1982), loess (Ext. Pub. C823), drainage basins (USGS 8- and 11-digit Hydrologic Units), groundwater, climate, and distributions of some key species (Liming, 1946; Batek, 1994), and satellite imagery of the state. Some of these maps were digitized especially for this ecoregion project. We also consulted previous maps of natural regions of the state (Marbut, 1896; Emerson, 1912; Sauer, 1920; Fenneman, 1931, 1938a, 1938b; Schottenloher, 1936; Cozzens, 1937, 1939; Collier, 1955; Hammond, 1958, 1964; Thornbury, 1965; and Omernik, 1987).

For descriptive purposes, we used hydrologic and climatological data as well as databases for rare and endangered species, natural areas, and public lands. We used the national vegetation classification system developed by The Nature Conservancy (TNC) (Faber-Langedoen, 2001) and the 2002 revision of Missouri Terrestrial Natural Communities (Nelson et al., in progress) to describe historic and current vegetation. A comparison of the natural community names used in this atlas with TNC and Missouri Terrestrial Natural Communities is in the appendix.

Interagency coordination and funding allocations were carried out in conjunction with the Missouri Resource Assessment Partnership (MoRAP), an interagency consortium to develop and apply spatial information toward natural resource conservation in Missouri. The section and subsection portion of the project was headquartered in the Department of Geography and the Geographic Resources Center of the University of Missouri–Columbia. LTA work was headquartered at the Missouri ECS project lab in the School of Natural Resources at UMC. Funding for the project was received from the Missouri Department of Conservation, the Mark Twain National Forest, and the North Central Forest Experiment Station.

HOW TO USE THE ATLAS AND ALLIED DATABASES

This atlas is designed to introduce the user to the sections, subsections, and landtype associations in Missouri through the use of maps and descriptive text. It has been formatted so that it can rest on the front seat of a vehicle, allowing the user to trace his routes within the state. The back cover has a template for locating the map plates and text pertinent to the user's location. The Overview of Missouri presents maps and descriptions of most statewide layers used in this classification effort. Following that are the ecological sections; each begins with an overall description of the ecoregion and how it is divided into subsections and LTAs. These are followed by standardized descriptions of each subsection, including tabular descriptions of the LTAs. A guide to the descriptions is located on page 7. Map plates of the subsections and LTAs in each section are located at the end of each section. The location of corresponding maps is identified on the title page for each subsection and on the LTA tables; the location of descriptive text is identified on each map. Links to the location of adjacent map plates are printed on each edge of each plate.

A CD-ROM with the atlas's text and figures, as well as coverages of the ecological units and diagnostic layers and databases associated with each LTA, is available from the Missouri Department of Conservation ECS Project (P.O. Box 180, Jefferson City, MO 65102). A multicolor wall map of the ecological units is also available.

The Central Dissected Till Plains is now a mosaic of cropland, pasture and second growth woodlands.

Paul Childress

A Guide to Subsection and LTA Descriptions

The subsection and LTA descriptions follow a standard format. The headings, their content, and the principle sources of information are described below.

GENERAL DESCRIPTION

A capsule summary of the physical and biological characteristics of the subsection, focusing on those characteristics that distinguish it.

LOCATION AND BOUNDARIES

A description of the general location of the subsection and the criteria used for locating the boundaries.

CLIMATE

A summary of climatic conditions including precipitation amount and distribution, temperature ranges, growing season, and other relevant climatic characteristics. Growing season was defined using 50 percent probability of frost cutoff dates, which results in lengths significantly longer than usually calculated for lower probabilities. Lower probabilities are more appropriate for annual field crops and garden plants than for native plants growing naturally.

TOPOGRAPHY AND GEOLOGY

A description of the shape of the land surface, changes in elevation (local relief), and major bedrock or surficial geologic parent materials. Local relief, or the amount of elevation change from a typical valley bottom to the adjacent ridge or summit, was a principle differentiating criterion. Topographic information was derived from Schroeder's "Landforms of Missouri" (an analysis based on USGS 1:24,000 quadrangles) as well as from digital and hard copy USGS quadrangles at 1:250,000 (subsections) and 1:100,000 (LTAs). Geologic information was derived primarily from statewide maps at 1:500,000 scale.

SOILS

A brief, nontechnical description of the soils and their distribution within the subsection, including parent materials and relevant depth, texture, and drainage characteristics. This information was derived from statewide general soils coverages including STATSGO and the Missouri General Soil Map, as well as county soil surveys. The descriptions were provided by NRCS staff.

HYDROLOGY

A description of the basins, streams, springs, wetlands, and other hydrologic features of the subsection, including gradients, channel morphology, water quality and quantity, channel engineering, and flooding. Information was derived from the *Missouri Water Atlas* and allied sources.

TERRESTRIAL NATURAL COMMUNITIES

Historic. A general description of the vegetation communities before Euro-American settlement. Information was derived from presettlement prairie maps, shortleaf pine historic distribution maps, and numerous written descriptions of historic Missouri.

Current. A general description of the current vegetation communities and land cover, including changes and overall conditions of existing natural communities. Information was derived from the current land cover map of Missouri (MoRAP 1999 Phase II Land Cover), the heritage database, and personal experience.

MAJOR NATURAL COMMUNITY TYPES

A list of the most common vegetation types, employing hybrid names formed by combining the vegetation-based designations of The Nature Conservancy's National Vegetation Classification with the physically based designations from the forthcoming revised *Terrestrial Natural Communities of Missouri.* A comparison of the types is provided in the Appendix. In the names, a comma between plant species denotes nearly equal importance of these species, while a hyphen indicates that the first species is usually more important; a slash (/) separates canopy from subcanopy or groundflora layers.

Note that the general terminology distinguishing forest, woodland, and savanna follows the current revision of *The Terrestrial Natural Communities of Missouri.* Forests have a closed canopy, multitiered structure, and shade-tolerant groundflora species. Woodlands have an open canopy that has 20–80 percent tree cover, an open understory, and dense, sun-loving groundflora species. Savannas are grasslands with scattered trees (less than 20 percent canopy) having common prairie groundflora species.

Rare and Restricted Natural Communities. A brief description of the small, rare, or regionally restricted natural communities associated with the subsection. Information is derived from the Missouri Natural Heritage database, natural features inventories, and personal knowledge.

NATURAL DISTURBANCES

A brief description of the natural disturbance regimes associated with the subsection. Information on fire history is based on Guyette and McGinnes's work, as well as personal observation.

RARE OR ENDANGERED SPECIES

A summary of the number and types of federal and state-listed plant and animal species, including principal habitats and regionally restricted species. Information is derived from the Missouri Natural Heritage database.

NATURAL AREAS

A summary and list of designated Missouri Natural Areas and what they represent in each subsection. Information is derived from digital coverages and attribute tables of Natural Areas.

PUBLIC LANDS

A summary of the amount and ownership of public conservation lands and Nature Conservancy preserves in the subsection. Information is derived from digital coverages of public lands in Missouri.

HUMAN GEOGRAPHY

Demographics. A summary of the Native Americans, early European and American settlers, and current population in the subsection. *American* is used in the traditional and well-understood sense of a person who lives in the United States of America or the preexisting English colonies.

Economics and Land Use. A summary of historic and current economic activities and dominant land uses.

LANDTYPE ASSOCIATIONS

An introduction to the landtype associations in the subsection, including their number and general character. Tabular descriptions of the LTAs follow the subsection description.

CONSERVATION CHALLENGES AND OPPORTUNITIES

A brief synopsis of some of the challenges and opportunities for conserving the native plant and animal communities of the subsection.

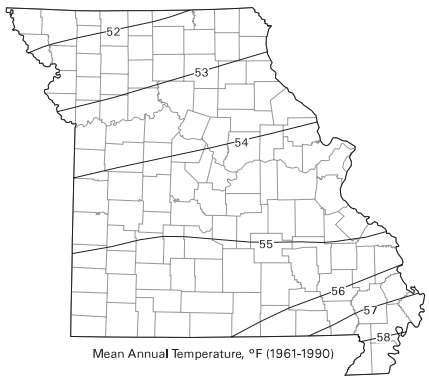
LANDTYPE ASSOCIATIONS TABLES

A table listing all LTAs in the subsection, giving an overall description of the LTA, especially its distinguishing characteristics, and describing the general location and criteria used in delineating its boundary.

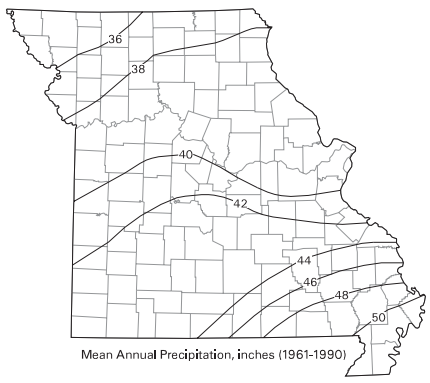
Overview of Missouri

CLIMATE

Missouri has a continental type of climate marked by strong seasonality. In winter, dry, cold air masses, unchallenged by any topographic barriers, periodically swing south from the northern plains and Canada. If they invade reasonably humid air, snowfall and rainfall result. In summer, moist, warm air masses, equally unchallenged by topographic barriers, swing north from the Gulf of Mexico and can produce copious amounts of rain, either by fronts or by convectional processes. In some summers, high pressure stagnates over Missouri, creating extended droughty periods. Spring and fall are transitional seasons when abrupt changes in temperature and precipitation may occur due to successive, fast-moving fronts separating contrasting air masses.



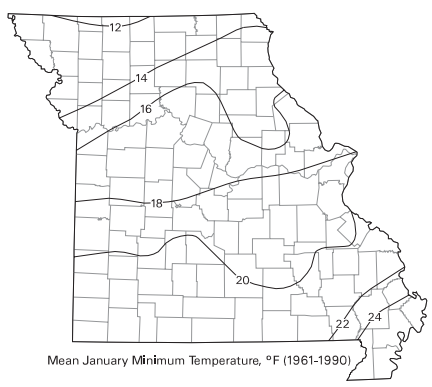
Mean Annual Temperature, °F (1961-1990)



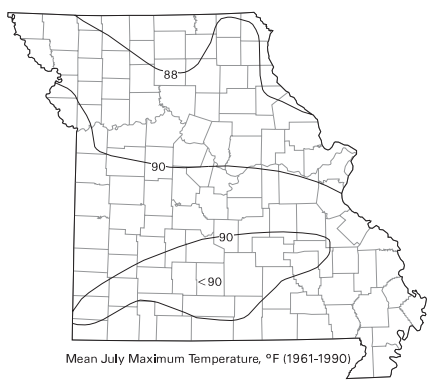
Mean Annual Precipitation, inches (1961-1990)

Missouri experiences regional differences in climates, but these differences do not have obvious geographic boundaries. Regional climates grade inconspicuously into each other. Nevertheless, several basic principles help to understand climatic differences in Missouri.

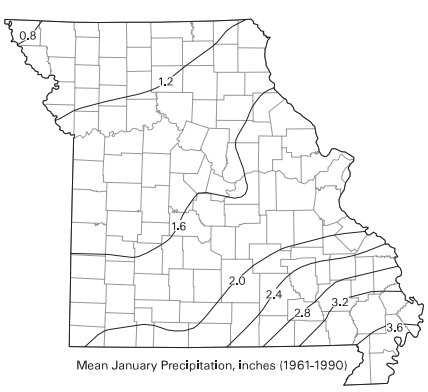
The basic gradient for most climatic characteristics is along a line diagonally crossing the state from northwest to southeast. Both mean annual temperature and precipitation exhibit gradients along this line. Mean annual temperature is lowest, 52°F, in the northwestern corner of the state and gradually increases southeastward to a high of 58° in the bootheel. Mean annual precipitation varies along the same gradient, from a low of 34 inches in the northwest to a high of 50 inches in the southeast.



Mean January Minimum Temperature, °F (1961-1990)



Mean July Maximum Temperature, °F (1961-1990)

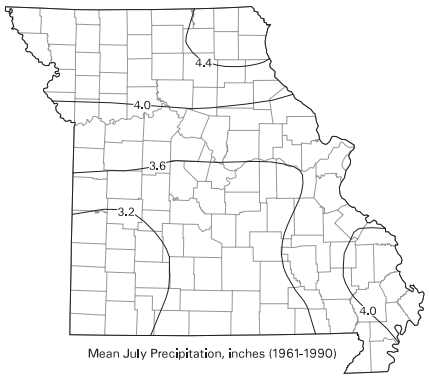


Mean January Precipitation, inches (1961-1990)

Source: Wendel, et al., 1992, Huff and Angel, 1992

Seasonal climatic variations are more complex. Mean January minimum temperature follows the same gradient, from a low of 12° in the northwest to a high of 24° in the southeast. However, mean July maximum temperature shows hardly any geographic variation in the state. Mean July maximum temperatures have a range of only three or four degrees across the state (87° to 90°), and the central Ozarks averages somewhat cooler July temperatures than other portions of southern Missouri.

Mean January precipitation varies along the gradient from a low of 0.8 inches in the northwest to a high of 3.6 inches in the southeast. However, mean July precipitation is greatest in northeastern Missouri, largely the result of high-intensity convectional precipitation (4.4 inches), and least in southwestern Missouri (3.2 inches). Though much less precipitation falls in northern Missouri in the winter than in the summer, it tends to be seasonally effective precipitation, since temperature and evaporation rates are much lower in winter. The mean annual snowfall is 24 inches in the northwest and only 8 inches in the southeast.

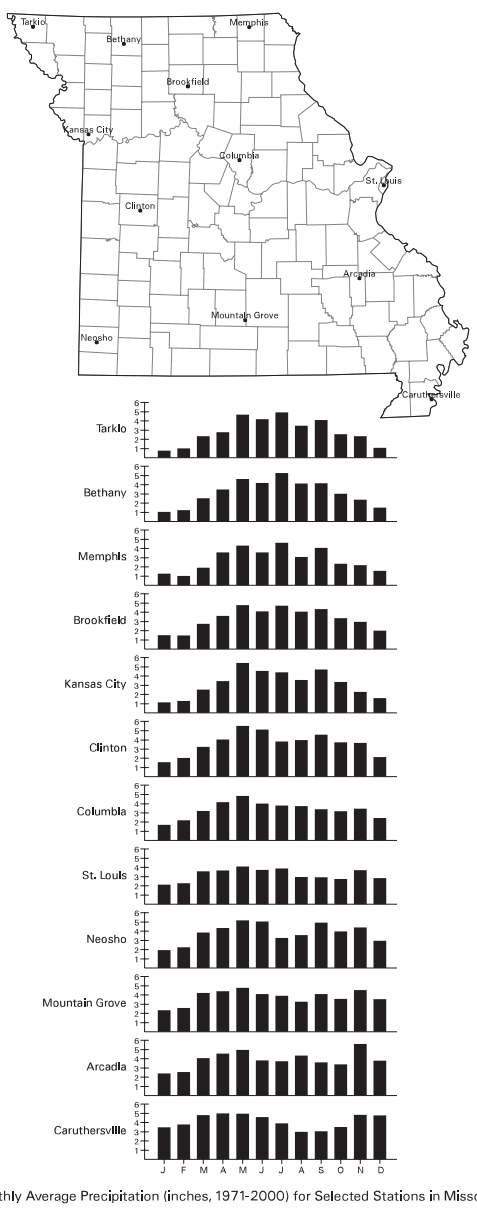


Mean July Precipitation, inches (1961-1990)

Mean Annual Snowfall, inches (1961-1990)

Mean monthly precipitation amounts are shown graphically for selected locations in Missouri on the map below. In northwestern Missouri, seasonality in precipitation is very pronounced due to strong continental influences. June precipitation, for example, averages five times greater than January precipitation. In contrast, in southeastern Missouri, seasonality in precipitation is insignificant due to the greater influence of subtropical air masses throughout the year. A conspicuous pattern to the graphs in much of Missouri is the midsummer (July–August) drop in precipitation, as shown best at Neosho and Clinton; less precipitation tends to occur in the hottest months just when demand for moisture is greatest.

All of Missouri experiences freezing temperatures every year. In northwestern



Monthly Average Precipitation (inches, 1971-2000) for Selected Stations in Missouri

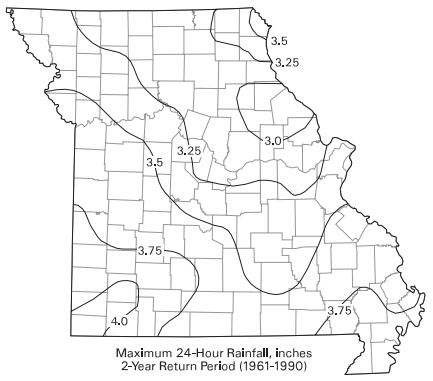
Source: Missouri Climate Center, 2001

Missouri, the average date (defined as 50 percent chance; as many freeze dates before as after the date), of the last spring moderate freeze (defined as temperatures in the range of 24–28°) is April 10. The average date of the first fall moderate freeze is October 25. In southeastern Missouri, the comparable dates are March 16 and November 20. Thus, the average length of the growing season by this liberal definition in northwestern Missouri is 198 days, and in southeastern Missouri it is 250 days. This is the definition of "growing season" used in the subsection descriptions that follow. However, the date after which there is still a 20 percent chance of moderate freeze in spring (one freeze expected during a five-year period) in northwestern Missouri is April 20, and the date before which there is a 20 percent chance of moderate freeze in fall is October 15. In extreme southeastern Missouri, the comparable dates are March 26 and November 3. Thus the length of growing season for these probabilities of freeze is much shorter and is more likely to be used for agricultural crops. The length of the growing season by this definition drops to only 178 days in northwestern Missouri and 223 days in extreme southeastern Missouri. For both probabilities (50 percent and 20 percent), for both spring and fall, the higher elevation of the Ozarks interrupts the north-south gradient across Missouri. The growing season in the Ozarks is measurably shorter than in adjacent, lower regions.

The metropolitan areas of St. Louis and Kansas City exert a significant and measurable effect on their climates. Temperatures are elevated in both regions by a few degrees, an effect known as the "urban heat island." More atmospheric particulates create a "dirtier" atmosphere of less intense light and a greater abundance of condensation nuclei. Somewhat cloudier skies and more hours of very light precipitation may result, although the total amount of precipitation may not be greater than in nonmetropolitan areas.

All of Missouri experiences "extreme" climate events, and such events must be considered part of the normal climate. Though infrequent in occurrence and often very geographically restricted, these "disturbances" produce environmental changes that may not otherwise have happened and that may be relatively long lasting in their effect. Among these extreme climatic events are high-intensity rains, protracted drought, heat waves and cold waves, ice storms, windstorms, and tornadoes. These climatic events, in turn, may lead to other environmental disturbances such as floods, fires, landslides, and abrupt changes in plant and animal populations and distributions.

High-intensity precipitation characterizes all regions of Missouri. The town of Holt in northwestern Missouri holds the national record for a high-intensity rain, having received 12 inches within a 42-minute period on June 22, 1947. Once every two years in southwestern Missouri one should expect one precipitation event to produce at least 4 inches of rain in a 24-hour period. Over a five-year period, one should expect one precipitation event to produce at least 5.5 inches of rain in a 24-hour period. Over a one-hundred-year period one event is expected to produce at least 9 inches of rain in a 24-hour period. Probabilities decline to the north and east away from southwestern Missouri.



Maximum 24-Hour Rainfall, inches
2-Year Return Period (1961-1990)

Drought may be conceptualized in different ways. Meteorological drought, based on precipitation records, is different from agricultural or soil-moisture drought and the physiological drought of plants. Drought is commonly thought of as a growing-season phenomenon, but precipitation deficiency during colder months does affect moisture abundance during the following warmer months. If drought is defined as a month during which less than 40 percent of normal precipitation for that month is received, then the average probability of such a dry month, based on records at Columbia, is about 15 percent, or one in seven years. For the months of April and May, the probability reduces to 8 percent, but for August and September, it rises to 18 and 21 percent, respectively, or one in five years. Thus, monthly precipitation is more variable in August and September than in April and May. The probability of three consecutive months receiving less than 60 percent of mean precipitation, again at Columbia, for the months of April through October, is 13 percent, or about one year in eight. There is no convincing evidence that severe droughts occur in Missouri with any cyclic regularity.

Drought directly affects plant and animal life by limiting water supplies, especially at times of high temperatures and high evaporation rates. Drought indirectly affects life by increasing plant and animal susceptibility to disease and the probability of fire and the severity of any fire.

As expected, minimum recorded temperatures are lowest in northern and western Missouri. The lowest temperature officially recorded in Missouri is -40° at Warsaw on February 13, 1905. Maximum recorded temperatures are also highest in northern and western Missouri. The highest temperature officially recorded in Missouri is 116° at Warsaw and Union on July 14, 1954.

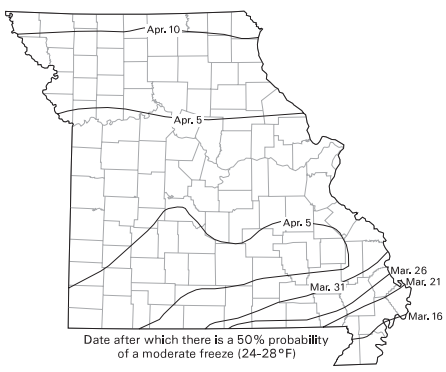
Temperatures below 0° have been recorded everywhere in Missouri. Northern Missouri records an average of 3–5 days with minimum temperatures below 0°, but in some years records no temperatures below 0°. Temperatures above 100° have also been recorded everywhere in Missouri. In northern Missouri, temperatures above 90° are recorded on an average of 40–50 days each year. In southern Missouri, the average is 65–75 days, except in the higher Ozarks, where summer maximum temperatures are somewhat lower.

Tornadoes occur in all regions of the state. During the period from 1954 to 1975, Missouri experienced an average of 33 tornadoes each year. May has the greatest frequency of tornadoes, and 70 percent of Missouri's tornadoes occur during March–June.

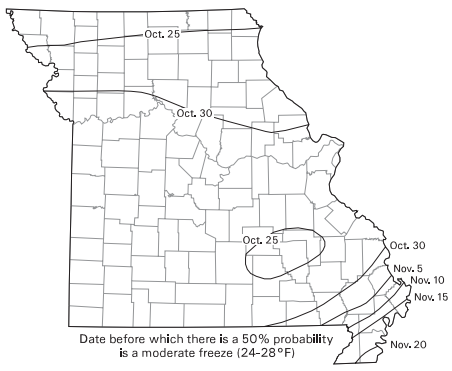
Hail also occurs in all regions and may occur throughout the year, but it is much less likely in winter. May has the greatest number of days with hail.

Superimposed upon the basic statewide climatic patterns are local topographic influences that create topoclimatic, or microclimatic, variations. In regions of appreciable relief, for example, air drainage at nighttime may produce temperatures several degrees lower in valley bottoms than on sideslopes. At critical times during the year, this phenomenon may produce later spring or earlier fall freezes in valley bottoms. Fog, heavy dew, and higher humidities are more common in low-lying areas. Deep sinkholes often have a microclimate significantly cooler, moister, and shadier than surrounding surfaces, a phenomenon that may result in a strikingly different ecology. Microclimate is also expressed by different wind speeds due to differences in the exposure of surfaces such as bluff faces. Higher daytime temperatures of bare rock surfaces and higher albedo (reflectivity) of unvegetated surfaces may create distinctive environmental niches such as glades and balds. Slope orientation (direction) is an important topographic influence on climate. South- and west-facing slopes are regularly warmer and drier than adjacent north- and east-facing slopes. Finally, the climate within a canopied forest is measurably different from the climate of adjacent open areas where most standard weather stations are located.

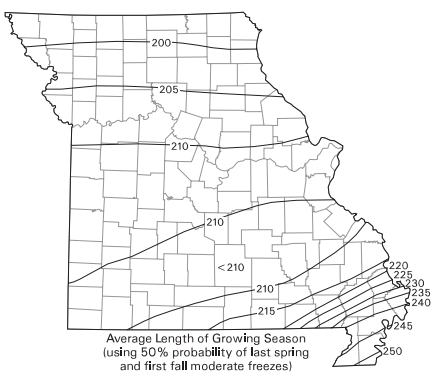
The length of daylight in Missouri (including refraction of sunlight), at latitude 39° north (approximately Columbia), varies from a low of 9 hours and 26 minutes on the December solstice to a high of 14 hours and 55 minutes on the June solstice. Thus, the annual range of length of daylight between the two solstices is approximately 5 1/2 hours. Comparable figures for latitude 36°30' north (the Missouri–Arkansas state line) are 9 hours and 40 minutes and 14 hours and 30 minutes, an annual range of less than five hours. Comparable figures for latitude 40°30' north (approximately the Missouri–Iowa state line) are 9 hours and 17 minutes and 15 hours and 4 minutes, or an annual range of just less than 6 hours.



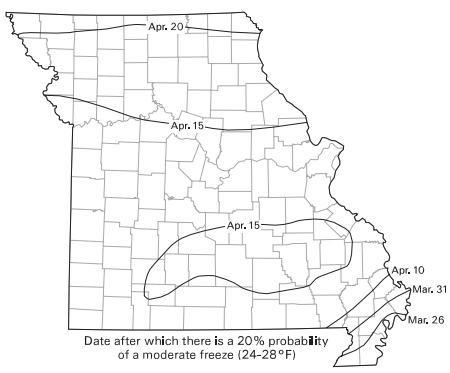
Date after which there is a 50% probability of a moderate freeze (24-28°F)



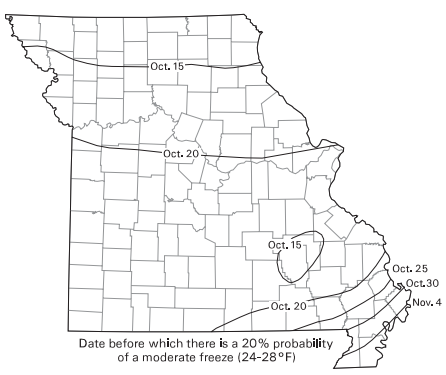
Date before which there is a 50% probability is a moderate freeze (24-28°F)



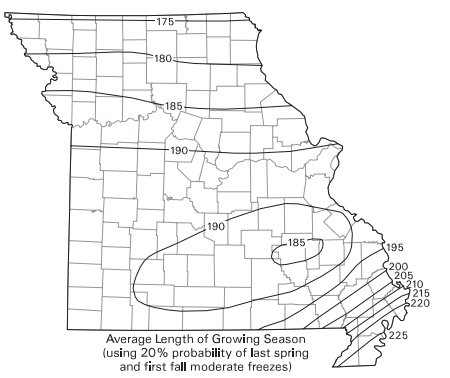
Average Length of Growing Season (using 50% probability of last spring and first fall moderate freezes)



Date after which there is a 20% probability of a moderate freeze (24-28°F)



Date before which there is a 20% probability of a moderate freeze (24-28°F)



Average Length of Growing Season (using 20% probability of last spring and first fall moderate freezes)

TOPOGRAPHY

The highest peak in elevation is the 1,772-foot summit of Taum Sauk Mountain in Iron County, although the highest continuous upland surface area, above 1,600 feet, lies in Webster County, over one hundred miles west of Taum Sauk.

The elongated Ozark crest, called the Ozark Divide, between the St. Francois knobs and southwestern Missouri, lies generally between 1,300 and 1,600 feet. The southward slope from the crest is steeper than the northward slope toward the Missouri River, causing the south-slope rivers to have steeper gradients than the north-slope rivers.

A broad topographical lowland lies at general elevations between 650 and 900 feet on the northwest flank of the Ozarks. It extends from southeastern Kansas to the lower Grand River in Chariton County. From this lowland, land elevation rises to more than 1,000 feet in Jackson County.

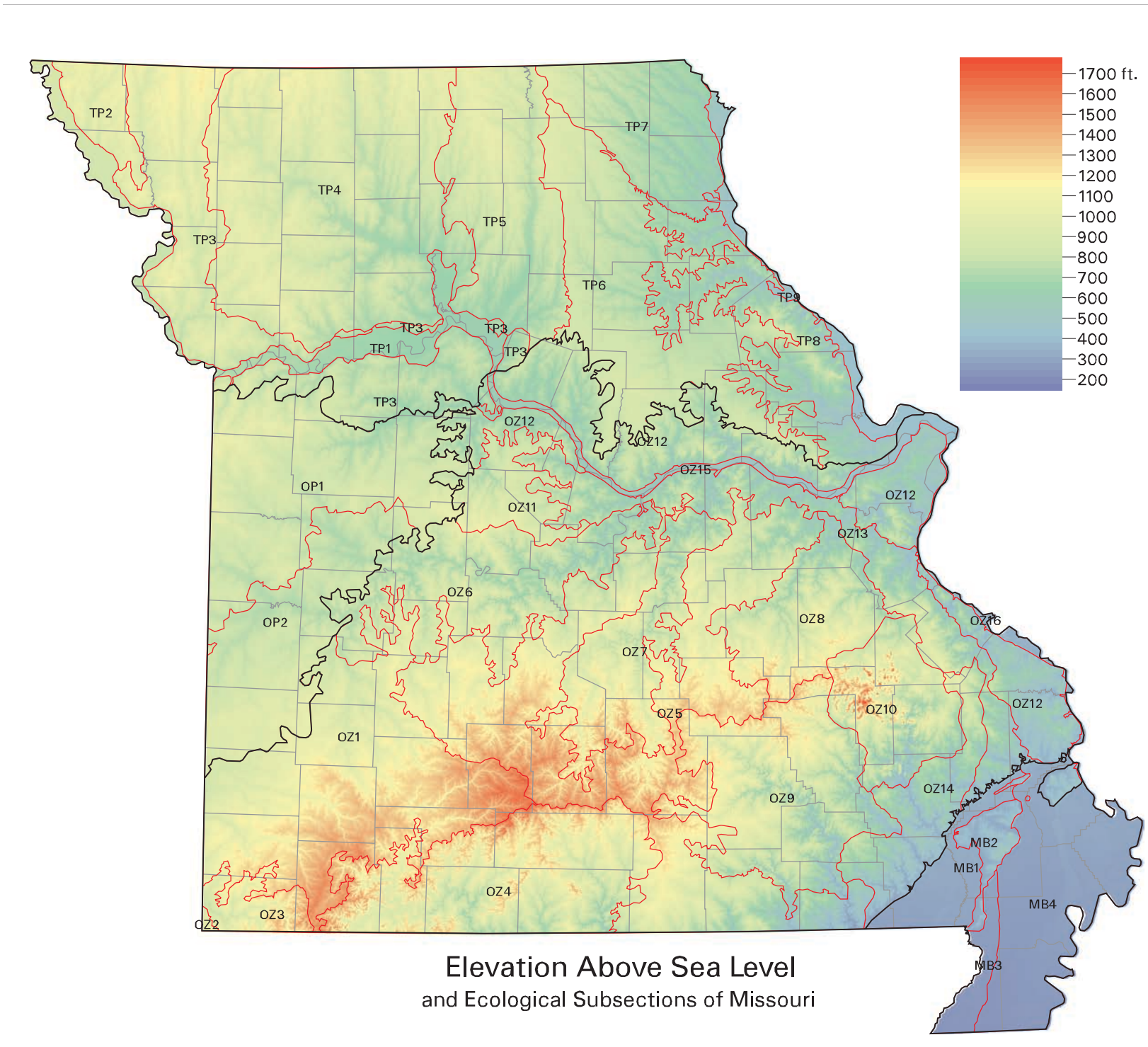
North of the Missouri River, the land continues to rise gradually northward, reaching elevations of 1,200 feet in northwestern Missouri, which are elevations comparable to the average elevation of the Ozarks. In northeastern Missouri, the Grand Divide, a flat-surface interfluve with elevations of 900–1,000 feet, reaching from Warren County to the Iowa line, separates the Missouri and Mississippi River drainages.

The southeastern lowlands lie between 240 and 335 feet in elevation, not including the isolated ridges that rise above the alluvial plain. This low-relief plain slopes southward from Cape Girardeau to the Arkansas state line at an average gradient of one foot per mile, and that southward slope accounts for much of the range of elevations of the alluvial plain. The lowest land elevation in Missouri is approximately 230 feet, where the Little River drainage ditches and the St. Francis River leave the state in Dunklin County.

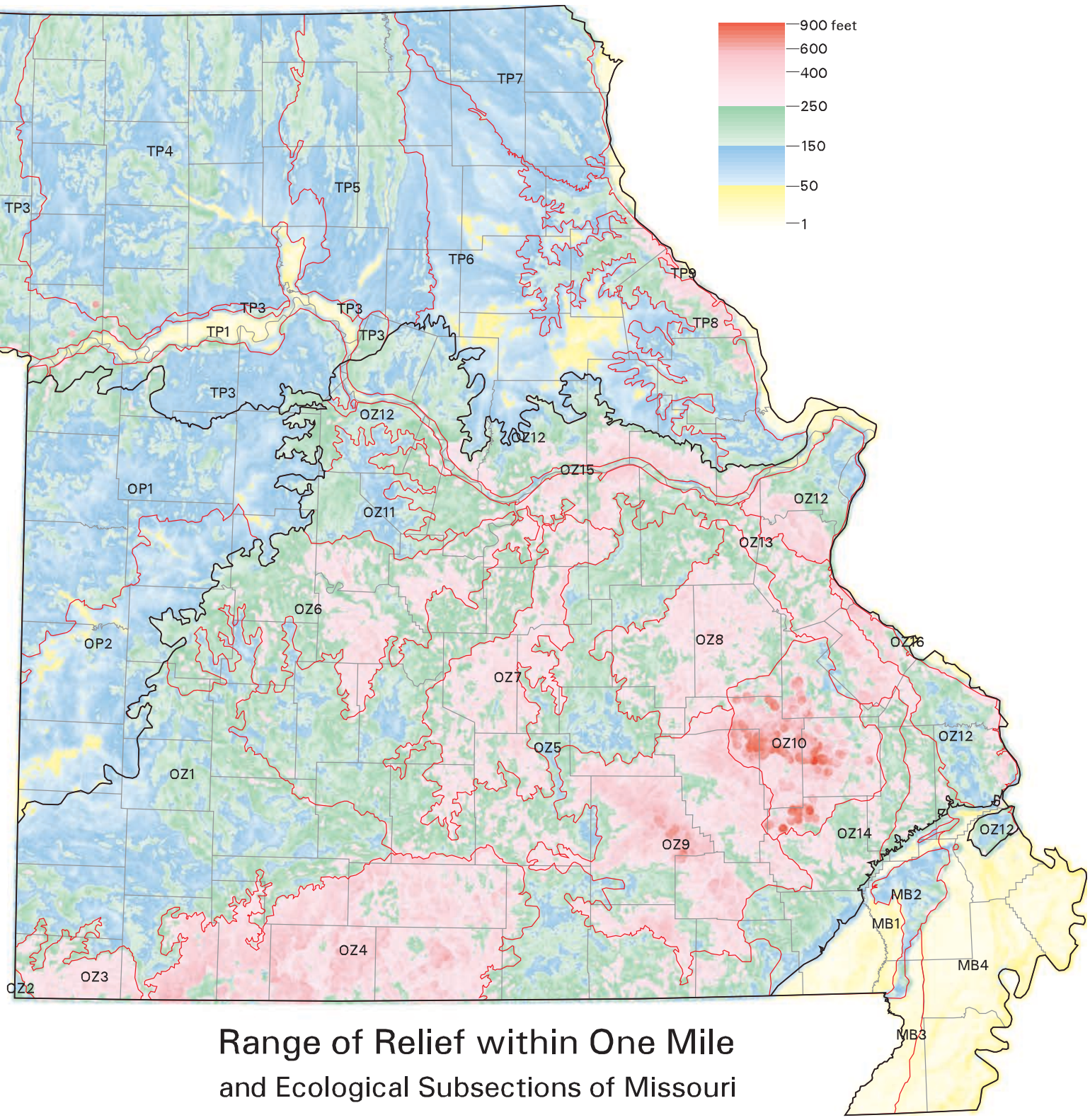
The prevailing land slope over most of Missouri, both in the Ozarks and in the upland plains, lies within the range of 3–10 percent. Gentle slopes, those less than 3 percent, characterize upland interfluves throughout the state. Gentle slopes are more extensive in southwestern, west-central, and northeastern Missouri where, in some places, the upland surface becomes essentially flat. Near-flatness also characterizes the alluvial surface of the southeastern lowlands. Steep slopes, those over 20 percent, are most common in the eastern Ozarks, the White River country, and locally elsewhere, especially in breaks and blufflands along the major rivers.

Relief is defined for this ecoregion atlas as "local relief," the difference between high and low elevations within a one- or two-mile distance or between a perennial stream valley and an adjacent major ridge. A visual depiction of local relief within one mile is provided on pg. 12.

It is immediately apparent that, except for the southeastern alluvial plain, the



Elevation Above Sea Level
and Ecological Subsections of Missouri



Range of Relief within One Mile
and Ecological Subsections of Missouri

surface is fluvially dissected to greater or lesser degrees, even the glaciated plains of northern Missouri. The pattern of stream dissection and local relief in Missouri consists of three major regions: Ozark highlands, plains, and southeastern lowlands.

The Ozarks are the most thoroughly dissected ecoregion in Missouri. Highest local relief is in the St. Francois knobs and basins, along the Current and Eleven Point Rivers, in the White River region, and along the Burlington Escarpment in the eastern Ozarks, where local relief is 400–600 feet. The highest relief measured in Missouri, within a one-mile distance, is 946 feet, in Madison County, between the St. Francis River and the summit of Black Mountain. Relief is generally 250–400 feet in most of the other river hills of the Ozarks. Relief is less in the western Ozarks and in the less-dissected interfluves of the Ozarks, where it averages 100–200 feet.

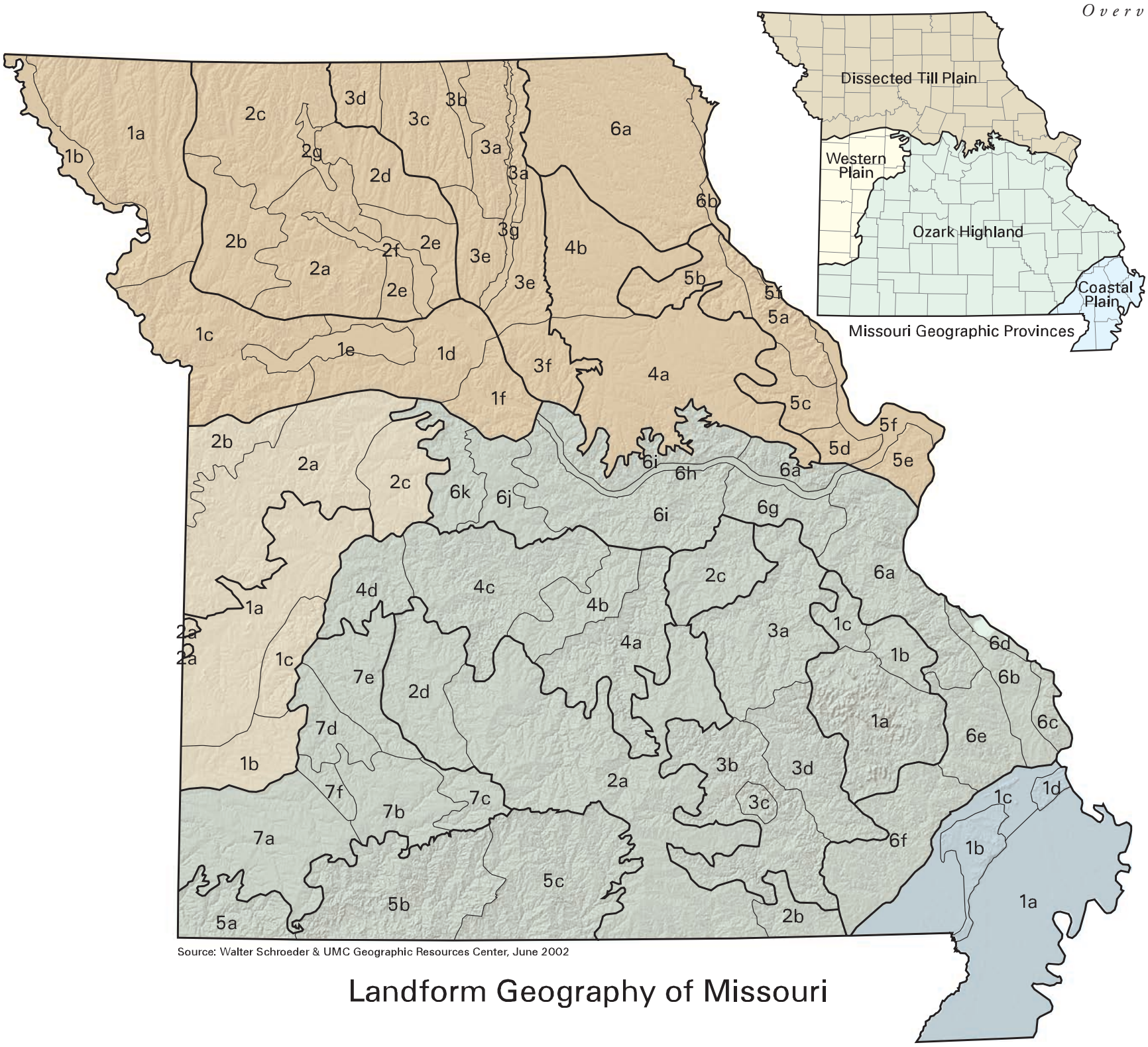
Throughout the plains of western and northern Missouri, stream dissection is less and relief averages 50–200 feet, generally about half that of most of the Ozarks, but it approaches Ozark numbers in the blufflands along the Missouri and Mississippi Rivers. Because of the prevalence of moderately steep slopes and moderately high relief in these areas, many of the ecoregion units in the plains are called "hills," while from a broader midwestern perspective, northern and western Missouri is regarded as "plains."

Relief is lowest in the broad alluvial plains of southeastern Missouri, where hardly any stream dissection has occurred and elevations commonly do not differ more than 20 feet over dozens of square miles. A significant fraction of this is accounted for by the southward slope of the plain. This landscape of very low relief is interrupted prominently by Crowley's Ridge, with relief up to 150 feet.

A map of landform regions of Missouri, based on relief, lithology, geomorphic process, and geographic pattern is shown on page 13. As would be expected, the divisions on the map are strikingly similar to the ecoregion subsections of Missouri, because landforms and geomorphology are basic factors in the creation of ecoregions at the subsection level. This map serves as an important starting point for ecoregion mapping. Differences are related to the added importance of soils and vegetation in ecoregion mapping.

GEOLOGY

The basic state geology map shows the geographic occurrence of formations by age. Most of the formations are Paleozoic in age. Ages are generally related to lithology (type of rock), but rocks of essentially the same lithology, like sandstone, can be present in formations of different ages. Lithology, much more than age of forma-



Source: Walter Schroeder & UMC Geographic Resources Center, June 2002

Landform Geography of Missouri

Coastal Plain Province

1. Southeastern Lowland Section
   - 1a. Eastern Lowland
   - 1b. Crowley's Ridge
   - 1c. Western Lowland
   - 1d. Benton Hills

Dissected Till Plain Province

1. Loess Hills Section
   - 1a. Nodaway Deep Loess Hills
   - 1b. NW Missouri Alluvial Plain
   - 1c. Missouri River Scarplands
   - 1d. Marshall Plain
   - 1e. Wakenda Alluvial Plain
   - 1f. Boonslick Hills

2. Grand River Dissected Plain Section
   - 2a. Glaciated Scarplands
   - 2b. Cameron Upland
   - 2c. Upper Grand River Hills
   - 2d. Trenton Hills
   - 2e. Meadville Plain
   - 2f. Grand River Alluvial Plain
   - 2g. Gilman City Upland

3. Chariton Hills Section
   - 3a. Upper Chariton Hills
   - 3b. Unionville-Green City Upland
   - 3c. Locust-Medicine Creek Hills
   - 3d. Weldon Hills
   - 3e. Middle Chariton Rolling Hills
   - 3f. Harrisburg Hills
   - 3g. Chariton Alluvial Plain

4. Glacial Plains Section
   - 4a. Audrain Plain
   - 4b. Shelby Plain

5. Mississippi River Hills Section
   - 5a. Lincoln Hills
   - 5b. Salt River Hills
   - 5c. Cuivre River Hills
   - 5d. St.Charles Low Hills
   - 5e. St. Louis Plain
   - 5f. Mississippi & Missouri Alluvial Plains

6. Wyaconda Dissected Plain Section
   - 6a. Wyaconda Ridges & Valleys
   - 6b. Upper Mississippi Alluvial Plain

Ozark Highland Province

1. St. Francois Knobs and Basins Section
   - 1a. St. Francois Mountains
   - 1b. Farmington Plain
   - 1c. Potosi Plain

2. Central Plateau Section
   - 2a. Central Plain
   - 2b. Ripley Dissected Plain
   - 2c. Bourbeuse Plain
   - 2d. Bolivar-Buffalo Plains

3. Courtois Hills Section
   - 3a. Meramec River Hills
   - 3b. Current River Hills
   - 3c. Eminence Knobs
   - 3d. Black River Hills

4. Osage-Gasconade Hills Section
   - 4a. Gasconade Hills
   - 4b. Iberia Upland
   - 4c. Lake Of The Ozark Hills
   - 4d. Truman Lake Hills

5. White River Hills Section
   - 5a. Elk River Hills
   - 5b. Branson Hills
   - 5c. North Fork Hills

6. Ozark Border Section
   - 6a. Eastern Ozark Cuestas
   - 6b. Perryville Karst Plain
   - 6c. Cape Hills
   - 6d. Bois Brule Bottom
   - 6e. Bollinger Hills
   - 6f. SE Ozark Hills & Flatwoods
   - 6g. Franklin Low Hills
   - 6h. Lower Missouri River Alluvial Plain
   - 6i. Central Missouri Hills
   - 6j. Tipton Upland
   - 6k. Lamine River Hills

7. Springfield Plain Section
   - 7a. Spring River Tableland
   - 7b. Springfield Karst Plain
   - 7c. Seymour Highland
   - 7d. Sac River Hills
   - 7e. Escarpment Hills
   - 7f. Chesapeake Fault-Line Hills

Western Plains Province

1. Cherokee Plains Section
   - 1a. Nevada Lowland
   - 1b. Golden City Plain
   - 1c. Clear Creek Plain

2. Osage Plains Section
   - 2a. Warrensburg Plain
   - 2b. Belton Upland
   - 2c. Pettis Plain

Source: Walter Schroeder & UMC Geographic Resources Center, June 2002

tion, is a primary factor in the configuration of the land surface, the formation of surficial material and soils, and presence of special features like karst.

The state geology map may be reduced to three primary patterns. In the Ozarks, the pattern is one of roughly concentric elliptical rings around a center in the St. Francois Mountains of the eastern Ozarks. The ellipses are elongated farthest from the center in a southwest direction towards Oklahoma. The geologic structure of the Ozarks is that of a broad dome with its center in the St. Francois Mountains, where the oldest rocks of Missouri are exposed at the surface. These are Precambrian igneous rocks of more than one billion years in age. They are followed successively by elliptical rings of Cambrian sandstones and dolomites and Ordovician dolomites, sandstones, and limestones. The most widespread formations are the Cambrian Eminence and Potosi dolomite (Cep), Ordovician Gasconade dolomite (Og), Ordovician Roubidoux sandstone and dolomite (Or), Ordovician Jefferson City–Cotter dolomite (Ojc), and Ordovician St. Peter sandstone (Osp). Beyond them, Silurian and Devonian formations of various lithologies are scattered in a narrow, discontinuous arc on the east and north. Still farther out from the structural center, Mississippian formations, chiefly limestones, almost completely encircle the dome. The most widespread of these are the Mississippian Osagean and Meremecian series limestones (Mo, Mm).

Dolomites and limestones, together called "carbonate rocks," greatly dominate the Ozarks. The prevalence of carbonate rocks causes all of the hill regions except the St. Francois Mountains to have broadly similar landform characteristics; the Ozark surface is one of repetitious broad uplands and ridges interspersed by valleys of varying depth and width. The carbonate rocks are soluble, and thus most of the surface is karstic to some degree. Many of the carbonate formations are strongly cherty. The smaller areas of igneous and sandstone formations interrupt the widespread carbonate surface with their own distinctive landscapes.

Because the stratigraphic dip away from the structural center is steeper eastward into Illinois than westward, the widths of the elliptical rings are much narrower on the east than on the west. In fact, the stratigraphic dip is hardly present westward from the center to Springfield, so that the Ozarks comes closest to being a true plateau along this broad crest, or axis, of the Ozarks. In general, this structural high is also a topographic high, and it serves as the regional drainage divide between north- and south-flowing rivers. The concentric ring pattern is abruptly truncated in the southeast by the straight Ozark Escarpment, which separates the Ozarks from the southeastern lowlands.

The second broad geologic pattern in the state trends northeast to southwest, lying to the north and west of the Ozark rings. This region in western and northern Missouri is composed mostly of Pennsylvanian-age formations. The most widespread are the Cherokee-Krebs limestone and shale (Pck), Marmaton limestone and shale (Pm), and the Kansas City Group limestone and shale (Pkc). These are "cyclic" formations and consist of alternating thin beds of shales (and coals), limestones, and sandstones, of which the shales account for the greatest surface area. The limestones and sandstones are more resistant to erosion, and where they occur they often create northeast–southwest belts of somewhat rougher terrain, called escarpments. All of the Pennsylvanian formations dip gently northwestward away from the Ozarks. Throughout most of northern Missouri, the Pennsylvanian formations are buried under glacial till. In northeastern Missouri (Marion, Ralls, Pike, and Lincoln Counties) a smaller, but pronounced, structure, the Lincoln Anticline or Fold, brings older Ordovician and Mississippian formations (mostly carbonate rocks) to the surface. The Lincoln Anticline region may be considered an outlier of Ozark geology and terrain on the north side of the Missouri River.

The third broad geologic pattern occupies Missouri southeast of the Ozark Escarpment. Here, bedrock is not important for landforms (except for Crowley's Ridge), and surface features are primarily the result of Tertiary, Pleistocene, and Holocene marine and alluvial deposition. This region of Missouri contains most of the epicenters of earthquakes associated with the New Madrid fault system. Numerous seismic events are recorded in the region each year, but the vast majority of them are not felt by humans.

HYDROGRAPHY

Streams in Missouri occur in a wide variety of sizes and patterns, from which inferences and associations may be made with geology, topography, and geomorphic process. *(See map on pg. 16.)*

The southeastern lowland (exclusive of the Mississippi River) is now a region of few natural alluvial rivers but hundreds of human-made drainage ditches and channels, many of them arrow-straight. The region's natural hydrography of perennial and seasonal wetlands has been more modified by human action than the hydrography of any other region of Missouri. The region lost a major input of runoff from the Ozarks when the Headwaters Diversion Channel was excavated across southern Bollinger and Cape Girardeau Counties, diverting several streams directly to the Mississippi at Cape Girardeau.

In the Ozarks, streams may be conveniently divided between south-slope and north-slope drainage systems. The White, Norfork, Eleven Point, Current, Black, and St. Francis are the chief south-slope systems, and the Osage (including the Sac, Pomme de Terre, and Niangua), Gasconade, and Meramec are the chief north-slope systems. All of the major Ozark streams are considered to be entrenched into the region's bedrock and have meandering valley patterns. Because of this deep entrenchment into water-bearing strata, all Ozark streams are influenced to some degree by groundwater flow from large springs. Base flow, as opposed to surface-water runoff, comprises a significant proportion of stream discharge. Ozark stream systems are dendritic in pattern, although some (especially the Osage, Gasconade, Meramec, and Black) have strongly asymmetrical patterns with more, larger, and longer tributaries on one side of the trunk stream. In general, Ozark stream channels have been less affected by channel engineering activities, such as straightening and bank stabilization, than streams elsewhere in the state.

In northern Missouri, subparallel patterns of drainage prevail. In the northeast, as far west as Putnam County, subparallel streams flow southeasterly. In the north-center and northwest, streams (except the trunk of the Grand River) flow almost due south. The channels of the streams in northern Missouri are naturally intensely meandering on broad, wet alluvial plains, but many of them have been straightened by channelization.

In west-central Missouri, stream patterns are dendritic. Channels, formerly low-gradient and intensely meandering on very broad alluvial plains, have been straightened by channelization.

The Spring, Elk, and upper James Rivers in southwestern Missouri are the only sizable streams in Missouri that flow westward. The first two are part of the Neosho (Grand) River system, which is part of the Arkansas River system.

The channels of both the Mississippi and Missouri Rivers have been significantly modified by channel engineering, largely for navigation, flood-control, and bank-stabilization purposes. The Mississippi River above St. Louis has been modified by a series of low dams with locks for barge navigation. Below St. Louis, channel engineering basically takes the form of bank stabilization. The Missouri River throughout the state has been narrowed by engineering works to approximately one half of its former width and deepened as a result. Most islands have been eliminated, meanders rounded for navigation, and banks stabilized by rock revetments and rock dikes.

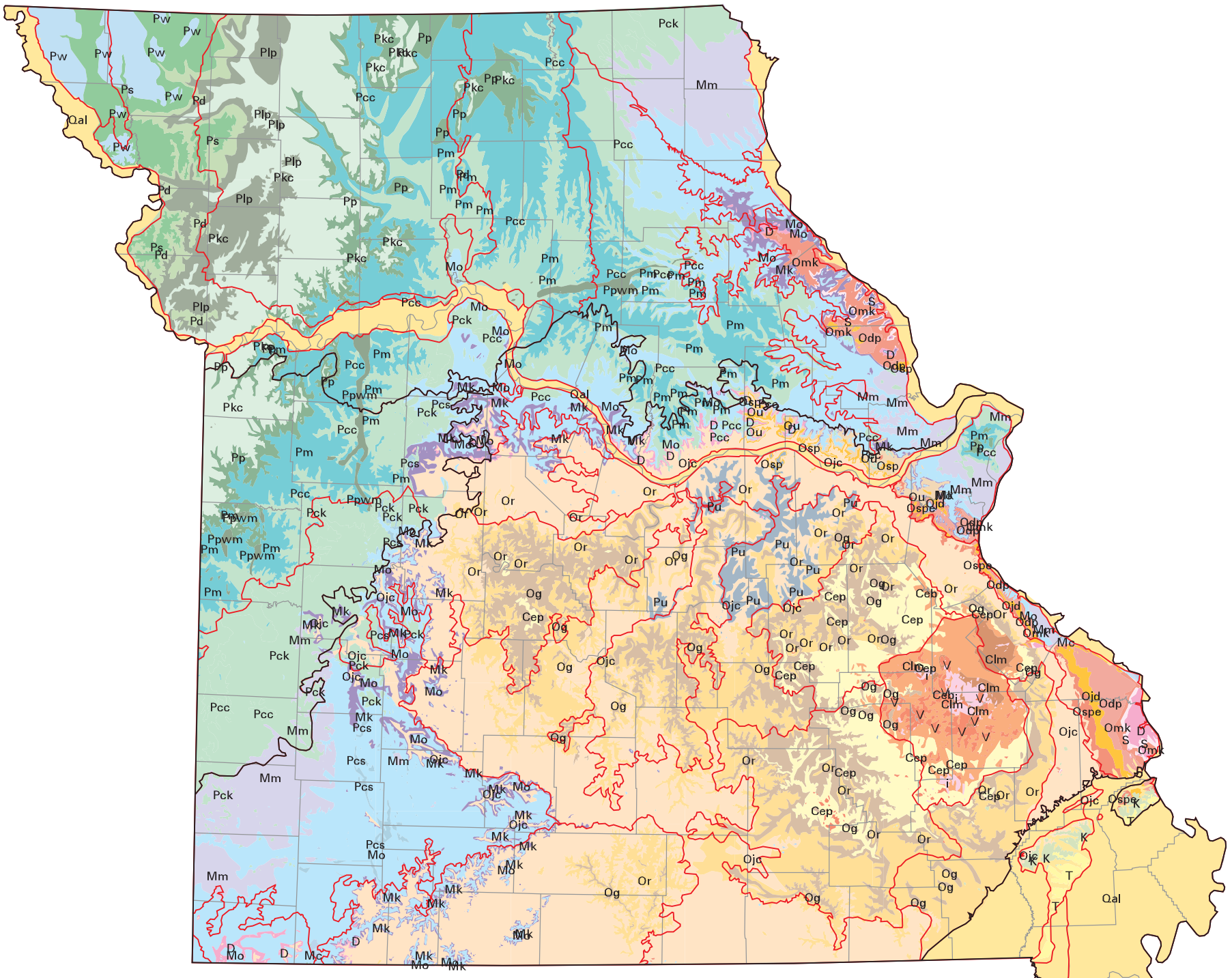
Areas that are conspicuous on state maps for their lack or sparsity of streams are of three types. Some are well-developed karst plains (Perry, Greene, Christian, and St. Louis Counties), some are urbanized areas (Jackson and Greene Counties; St. Louis city), and some are permeable alluvial surfaces (Holt, St. Charles, New Madrid, and other counties in the southeastern lowlands).

"Losing streams," or "sinking streams" are streams in which a portion of the discharge is known to be lost through the streambed to underground flow. Probably many losing streams have yet to be identified. Those identified so far are located in the carbonate, karst regions of the Ozarks and are prominent in the James and Finley basins south of Springfield, in the drainage basins around West Plains, and in the Niangua, Auglaize, Roubidoux, upper Meramec, upper Current, and upper Black River basins. The water lost from these streams often feeds large springs and it may reemerge in streams of other drainage basins. *(See map on pg. 16.)*

The only natural lakes in Missouri are oxbows (former river channels) in river alluvial plains, sinkhole ponds in karst regions, and, by far the most numerous, lakes in the wetlands of southeastern Missouri. Some of these wetlands were true perennial lakes of open water, but most were swamps of seasonal wetness. Virtually all of the extensive wetlands of southeastern Missouri have been drained. Other alluvial wetlands occur along the Grand and other rivers in northern Missouri and along the upper Osage and other rivers in west-central Missouri. Many of these have also been drained.

Human-made lakes and ponds are ubiquitous across the state and represent one of the most conspicuous changes in the hydrographic landscape. Because of them, surface water is much more locally accessible to animals and fish than in earlier times, before the twentieth century. Estimates of the number of ponds and small lakes in Missouri range as high as 300,000, or an average of almost five per square mile throughout the state. However, they are much more numerous per square mile in the northern and western plains regions than in the Ozarks. Many are small ponds (less than one-half acre) for stock watering. Lakes also occupy strip pits of former coal mines. Other lakes have been constructed for residential developments and water supplies. The largest lakes, those created by dams of the U.S. Army Corps of Engineers and electric power companies, are most numerous in the western Ozarks. The largest impoundments in Missouri by surface area are the Lake of the Ozarks (60,000 acres at normal or conservation pool) and Harry S. Truman Reservoir (55,600 acres, which expands to 209,300 acres or 327 square miles at maximum flood-control pool elevation). The Gasconade, Meramec, and Current Rivers of the eastern Ozarks have no large dams or lakes on them and therefore are Missouri's largest "free-flowing" rivers.

The surface of Missouri was essentially created by fluvial, or stream, processes operating on different types of earth materials. The numerous drainage basins organize the land surface into units of energy flow and geomorphic development and form natural geographic units for land, water, and biological management purposes. They exist in hierarchical systems, from the small basins of fingertip or "first-order" streams, to the huge basins of the Osage, Missouri, and Mississippi Rivers. All of Missouri lies within the Mississippi River basin, and about half of the state within the Missouri River basin. Basin shapes range from the compact Lamine and Cuivre basins to the elongated Platte, Pomme de Terre, and North Fabius basins. Basin shapes affect the nature of flooding. It should be noted that subterra-



Bedrock Geology
and Ecological Subsections of Missouri

Cenozoic

Quaternary
- Qal - Alluvium

Tertiary
- T - Sandstone & Shale

Mesozoic

Cretaceous
- K - Siltstone & Sandstone

Permian
- Pic - Indian Cave Sandstone

Paleozoic

Pennsylvanian
- Pw - Wabaunsee Group Limestone & Shale
- Ps - Shawnee Group Limestone & Shale
- Pd - Douglas Group Limestone & Shale
- Plp - Lansing-Pedee Limestone & Shale
- Pkc - Kansas City Group Limestone & Shale
- Ppwm - Warrensburg Channel Sandstone
- Pp - Pleasanton Sandstone & Shale
- Pm - Marmaton Limestone & Shale
- Pcc - Cherokee-Cabaniss Limestones
- Pcs - Channel Sandstone
- Pu - Pennsylvanian Undifferentiated
- Pck - Cherokee-Krebs Limestone & Shale (Coal)
- Ph - Hale Sandstone

Mississippian
- Mc - Chesterian Series Limestone & Sandstone
- Mm - Meramecian Series Limestone
- Mo - Osagean Series Limestone
- Mk - Kinderhookian Series Limestone & Shale

Paleozoic

Devonian
- D - Devonian Formations
- Dd - Diatremes

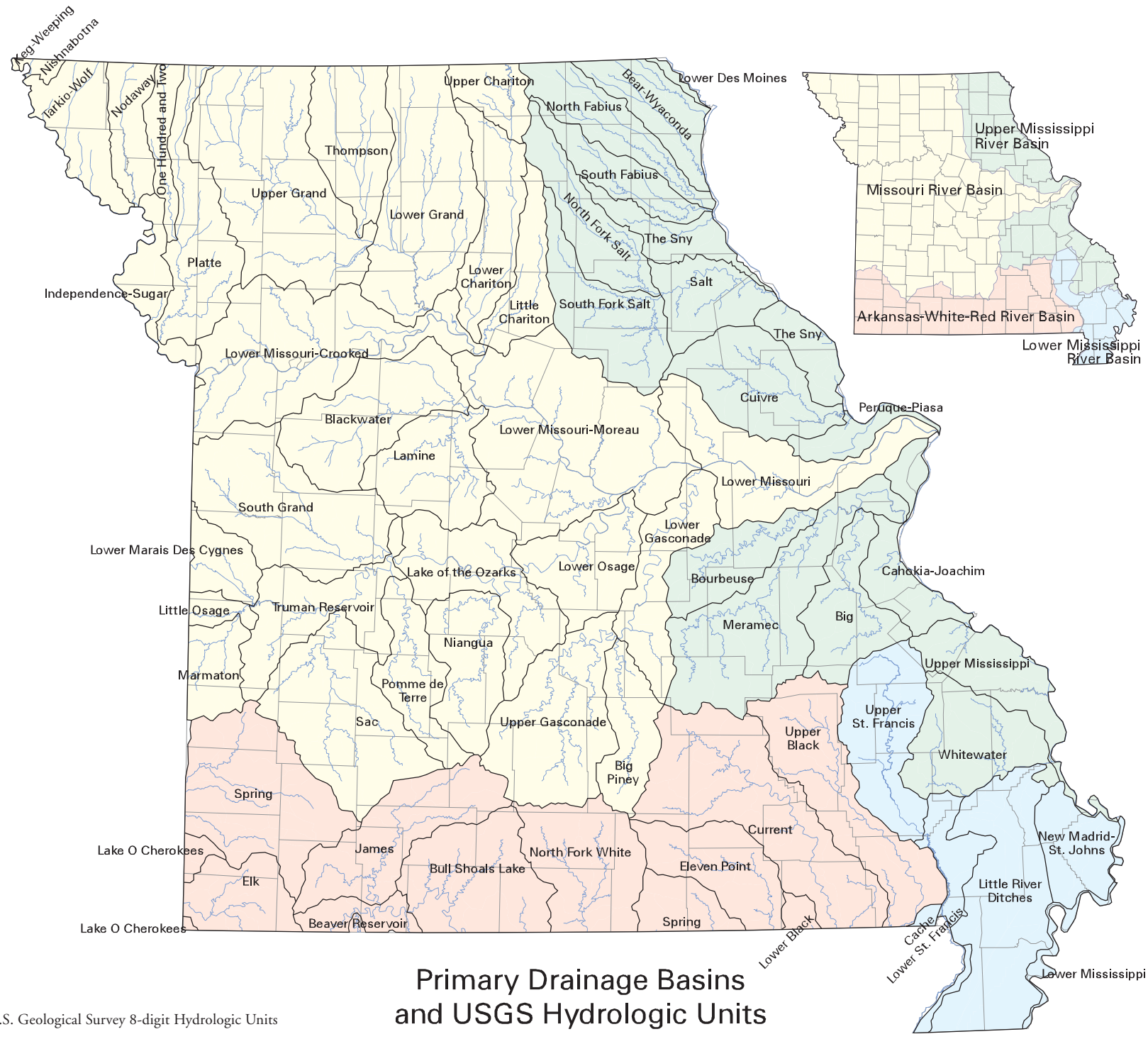
Silurian
- S - Undifferentiated Limestone

Ordovician
- Ou - Undifferentiated Dolomite
- Omk - Maquoketa-Kimmswick Shale & Limestone
- Odp - Decorah-Plattin Limestone & Shale
- Ojd - Joachim-Dutchtown Dolomite & Limestone
- Ospe - St. Peter-Everton Sandstone & Sandy Dolomite
- Osp - St. Peter Sandstone
- Ojc - Jefferson City-Cotter Dolomite
- Or - Roubidoux Sandstone & Dolomite
- Og - Gasconade Dolomite

Cambrian
- Cep - Eminence-Potosi Dolomite
- Ceb - Elvins Group & Bonne Terre Dolomite & Shale
- Clm - Lamotte Sandstone

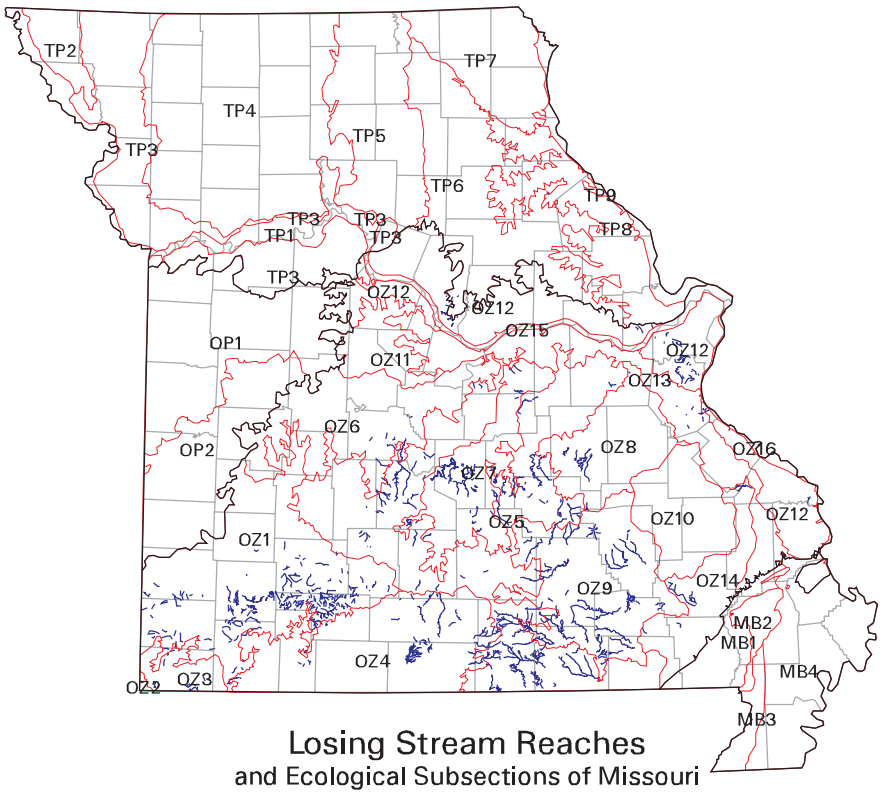
Precambrian
- d - Igneous Diabase
- i - St. Francois Mts. Intrusive Suite
- V - St. Francois Mts. Volcanic Supergroup

Source: Missouri Geological Survey–Missouri Department of Natural Resources



Primary Drainage Basins and USGS Hydrologic Units

Source: U.S. Geological Survey 8-digit Hydrologic Units



Losing Stream Reaches and Ecological Subsections of Missouri

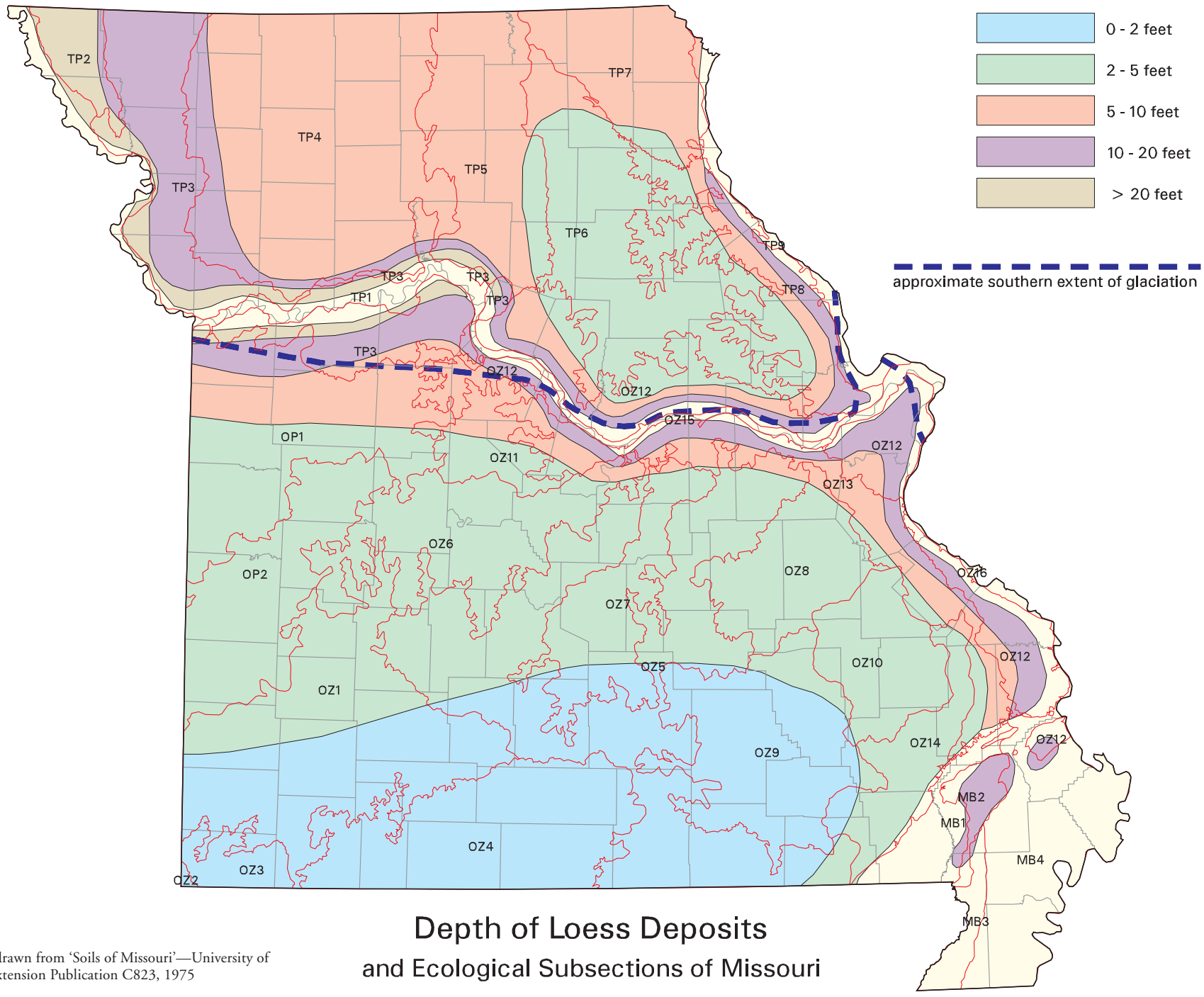
Source: UMC Geographic Resources Center (1995)

nean drainage in cavern systems may have substantially different geographic patterns and hydrographic basins than those shown for surface drainage. That is, a large spring may contribute water to a stream from a different geographic area than the mapped drainage basin for the stream. No state map yet exists that shows subterranean drainage basins.

PLEISTOCENE-HOLOCENE FEATURES

Several glaciers invaded Missouri during the Pleistocene Epoch, roughly the last two million years of earth history, but the great length of time since their recession has allowed postglacial erosional and depositional processes to rework the surface considerably and destroy much of the glacial landscape. "Fresh" glacial features are not present in Missouri; the land surface in glaciated regions is essentially a fluvial product constructed on a surface of glacial materials. The southern limit of Pre-Illinoisan glaciation (formerly separated into Kansan and Nebraskan stages) lies south of the Missouri River west of Jefferson City and north of the river east of that city *(see pg. 17)*. This boundary is a very generalized, inferred line and cannot be used for local purposes of high geographic resolution. For example, parts of Lincoln and Pike Counties north of the line show no evidence of ever having been glaciated, and, conversely, glacial erratics have been found south of the boundary south of the Missouri River in Jefferson City. A glacier of the later Illinoisan stage extended across the Mississippi River into Missouri at St. Louis. The most recent major stage of Pleistocene glaciation, the Wisconsinan, did not reach Missouri, although it was experienced through climatic, hydrologic, and biological changes.

The Missouri and Mississippi Rivers, and probably also the Des Moines, are the only true glacial meltwater streams of the state, and their alluvial plains are under-



Depth of Loess Deposits
and Ecological Subsections of Missouri

Source: Redrawn from 'Soils of Missouri'—University of Missouri Extension Publication C823, 1975

lain by as much as one hundred feet of glaciofluvial sediment. Other Missouri streams did not drain away from active Illinoisan or Wisconsinan glaciers, although their discharges fluctuated according to wetter and drier climatic episodes of the Pleistocene and Holocene. In addition to the Mississippi, the Ohio River in late glacial time deposited enormous amounts of glaciofluvial sediments in southeastern Missouri.

The thickness of Pleistocene glacial deposits (till) in northern Missouri varies greatly and often within short distances. In places where glacial deposits filled preexisting valleys, they may be over three hundred feet thick, but in most places till is less than one hundred feet. In many places, especially closer to the southern limit of glaciation, till has been completely removed by postglacial erosion, and the underlying Paleozoic bedrock appears at the surface.

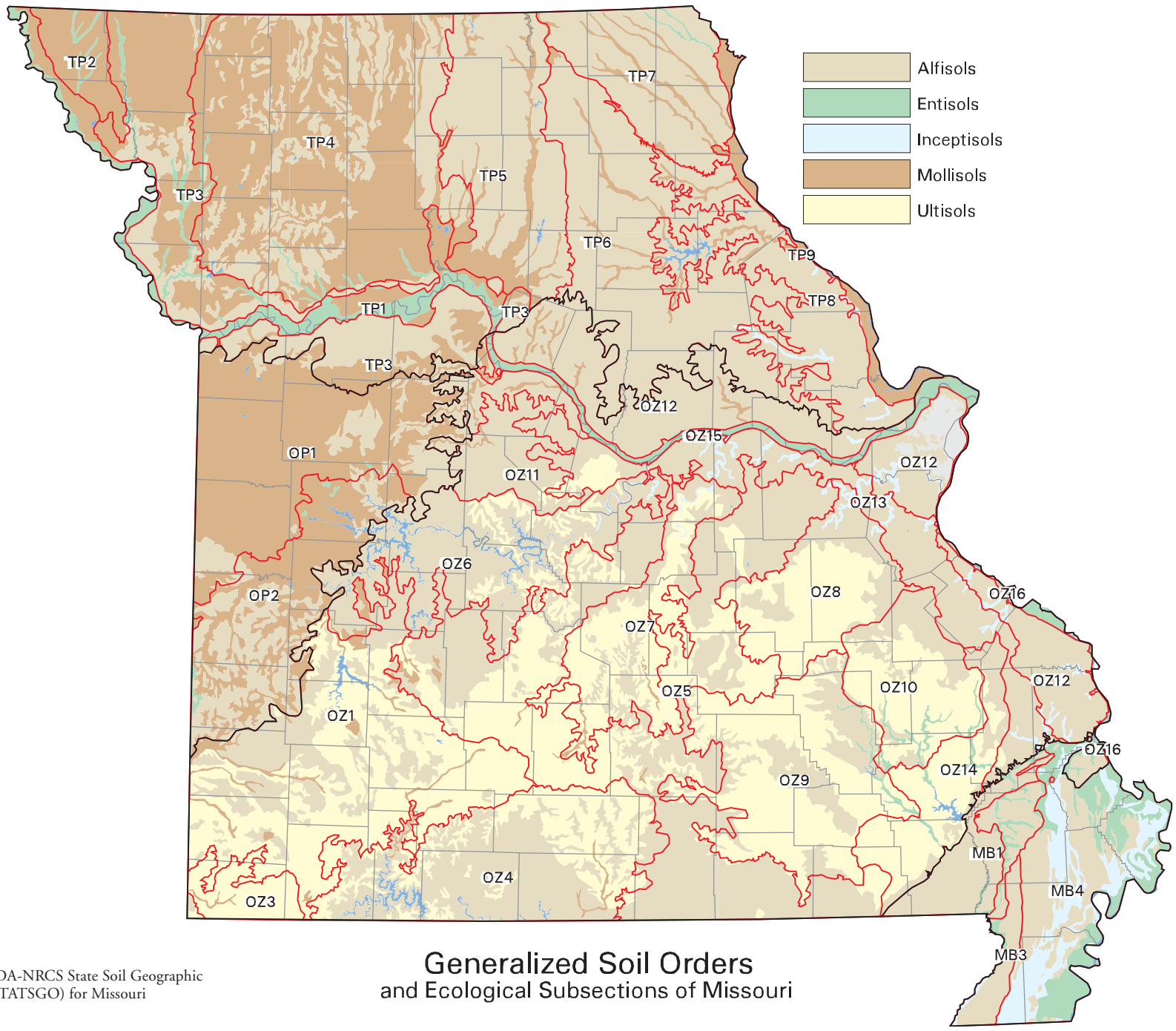
Loess (wind-deposited silt) is an important Pleistocene-Holocene feature associated with glaciation. As seen on the map, the generalized distribution and depth of loess lacks good spatial correlation with the ecoregional lines overlaid on it. Loess presumably mantled most of the state, but where it was formerly less than two feet thick, it has probably been either removed by soil erosion and redeposited in valleys or plowed into the residuum or glacial till beneath it. Even in northern Missouri, hillslopes may have had most of their loess mantle removed, although it continues to cap the ridges and uplands. Geographic variations in the thickness of loess reflect the function of the Missouri and Mississippi Rivers as Pleistocene meltwater streams. Loess has been measured to depths greater than one hundred feet in blufflands in northwestern Missouri, but these measurements may be from silted-in ravines or in deposits plastering exposed bluff faces and therefore exaggerate the general thickness of loess. Loess is thickest along the two major meltwater-river valleys and thins rapidly away from them. Loess is thicker, as a rule, in west- and south-facing blufflands of those two rivers, but in any one locality it is thicker on river-facing slopes than on slopes facing away from the river valley. Loess is thinnest in interior northern Missouri in locations farthest removed from the Missouri and Mississippi Rivers. It is also thin throughout the Ozarks. Crowley's Ridge has significant depths of loess on it.

SURFICIAL MATERIALS

Residuum derived from the physical disintegration and chemical decomposition (solution) of bedrock forms most of the land surface south of the Missouri River. In the Ozarks, residuum is usually from ten to forty feet thick, but it ranges up to two hundred feet thick and to even greater thicknesses locally. In most of the Ozarks, this material is primarily a cherty clay, cherty sandy clay, or cherty silty clay. The carbonate fraction of bedrock decomposes chiefly to clay, while the insoluble chert remains as rock fragments. The size of chert fragments and their percentage of the residual mass vary greatly. Percentages of rock fragments are lower on the smooth upland surfaces and higher on the hillsides of dissected areas. Because so much of the carbonate portion of the rock mass has been dissolved and removed, the insoluble lag chert usually forms a higher percentage of the residuum than it does in the parent bedrock.

Chert-free clays form the innermost lithologic belt around the St. Francois knobs. Small areas of sandy residuum lie just northeast of the St. Francois knobs in a very narrow arc from Cape Girardeau to Montgomery County and scattered elsewhere in the Ozarks wherever the parent material is sandstone. Often the toponym Sand Creek or Sandy Creek indicates local sandy residuum.

In the plains of west-central Missouri, the residuum is basically a clay, becoming



Source: USDA-NRCS State Soil Geographic Database (STATSGO) for Missouri

Generalized Soil Orders
and Ecological Subsections of Missouri

sandier closer to the Ozarks and siltier in the Kansas City region. Despite the low relief of the western plains, residuum is thinner (generally less than fifteen feet) than in any other major state region, and bedrock exposures are common.

The glacial till of northern Missouri is a silty clay or clay, but with locally coarser materials, especially where glacial deposits fill preglacial valleys. Glacial deposits in extreme northeastern Missouri are noticeably sandier. Paleosols (buried soils) and accretion gley, both formed by pedologic processes since the retreat of the glaciers, are major components of weathered till. Weathered till is several feet thick on smooth uplands but less thick on hillslopes. Where till is absent in northern Missouri, the surficial material is residuum formed from the weathering of Paleozoic sedimentaries. In the blufflands on both sides of the Missouri and Mississippi Rivers, loess is sufficiently thick to be considered the surficial material.

Alluvium forms the surficial material in the alluvial plains of all rivers and streams of the state. Texture varies widely within very short distances horizontally and vertically, depending on depositional environment. Tough, microscopic clays deposited in quiet water may occur next to coarse sands deposited as a result of levee breaks or deposited by former streams. Most of the alluvial material, however, is silt or sandy silt. Alluvium in the southeastern lowlands is silty and clayey, except on terraces of older alluvium, which tend to be sandy.

SOILS

The geography of soils in Missouri is complex. Several contrasting soils typically occur within a single hillslope sequence, and even seemingly uniform floodplains have highly variable texture and drainage patterns. However, there are broad regional patterns. The general soil map of Missouri separates the state into 107 different soil associations, each composed of several dominant soil series. From these associations a map was developed of the dominant soil *order* in each general soil map unit. Order is the highest category of the USDA's hierarchical Soil Taxonomy system and reflects regional trends in the soil-forming factors of vegetation, topography, parent material, climate, and time.

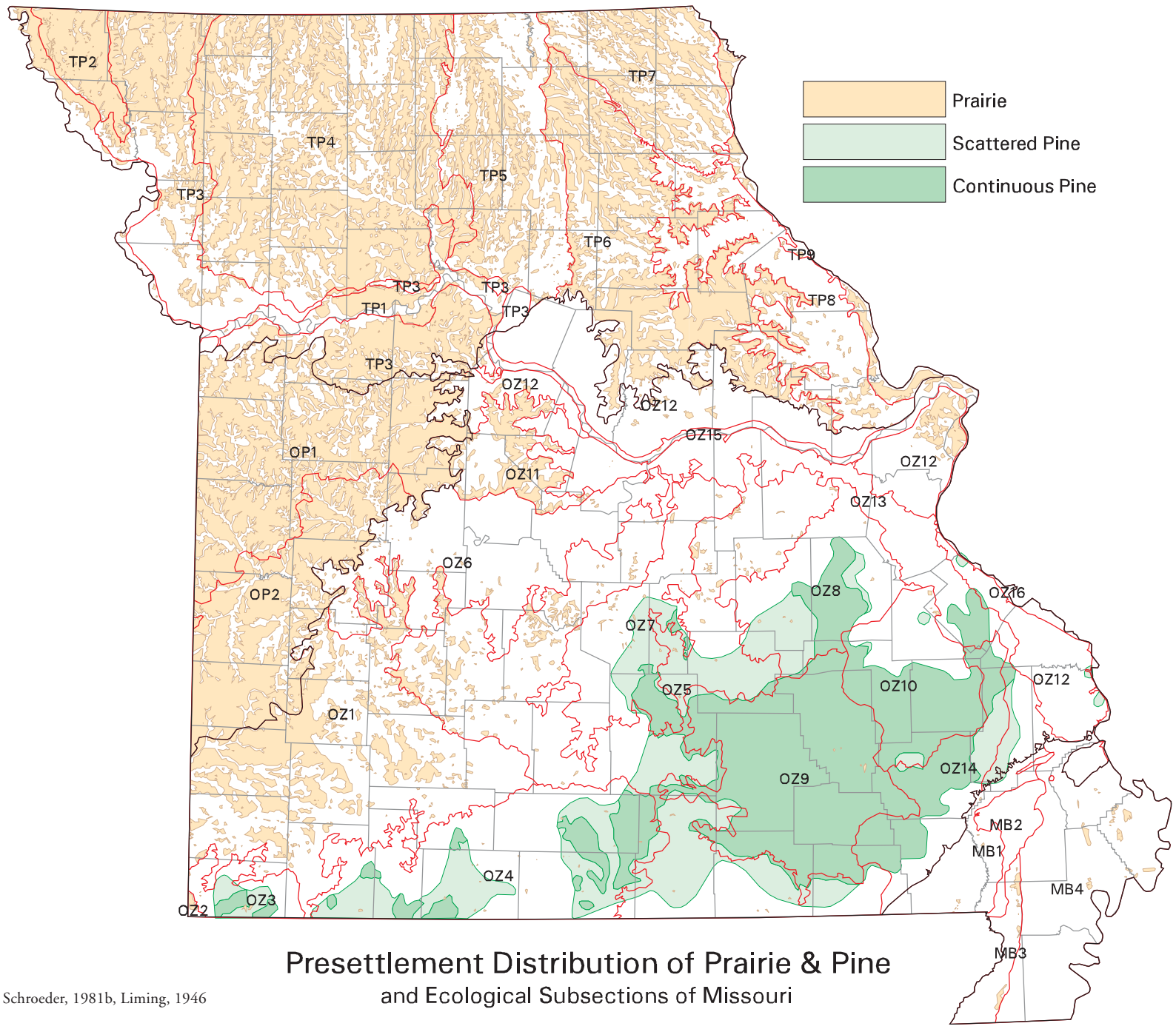
Mollisols are dominant in the western part of the Central Dissected Till Plains Section, particularly in the Deep Loess Hills and Loess Hills Subsections, and in the Osage Plains Section. These soils formed under prairie vegetation and have thick, dark surface layers with relatively high levels of soluble bases, such as calcium and magnesium. The mollisols in northwestern Missouri developed in loess of varying thickness and in the underlying glacial till, whereas the Osage Plains mollisols developed in thinner loess and the underlying residuum from sandstone and shale. In the Deep Loess Hills Subsection, most mollisols have silt loam to silty clay loam subsoils, whereas mollisols in other subsections generally have clayey subsoils. Most mollisols have silt loam or loam surface layers.

Alfisols occur throughout Missouri but are particularly dominant in the central and eastern subsections of the Central Dissected Till Plains Section and in the Ozark Highlands Section. These soils formed primarily under deciduous forest or woodland vegetation, although alfisols in the Claypan Till Plains Subsection are thought to have formed under prairie. Alfisols have thin, loamy surface layers, and most have clayey subsoils. Alfisols that formed under savanna or woodland vegetation, and the prairie alfisols of the Claypan Till Plains Subsection have thicker surface layers and are transitional to mollisols. Missouri alfisols are particularly diverse, primarily due to the variety of parent materials and landforms in which they have formed. For example, alfisols on the glacial till backslopes of the Central Dissected Till Plains Section have brown, clay loam and clay subsoils; alfisols on

Source: USDA–NRCS State Soil Geographic Database (STATSGO) for Missouri

Missouri STATSGO Soil Associations
and Ecological Subsections

1. Haynie-Leta-Waldron
2. Luton-Salix-Keg
3. Kennebec-McPaul-Nodaway
4. Colo-Nodaway-Zook
5. Monona-Ida-Napier
6. Marshall-Exira-Shelby
7. Sharpsburg-Shelby-Colo
8. Knox-Higginsville-Silbey
9. Lamoni-Shelby-Adair
10. Sharpsburg-Macksburg-Higginsville
11. Gara-Armstrong-Knox
12. Grundy-Lagonda-Lamoni
13. Gara-Armstrong-Pershing
14. Armster-Snead-Ladoga
15. Bremer-Cotter-Booker
16. Greenton-Gosport-Snead
17. Monona-Joy-Winterset
18. Lindley-Keswick-Goss
19. Armstrong-Gara-Adco
20. Carlow-Dockery-Fatima
21. Menfro-Winfield-Weller
22. Mexico-Putnam-Leonard
23. Mexico-Leonard-Armstrong
24. Nodaway-Lawson-Colo
25. Bardley-Gasconade-Cedargap
26. Lomax-Blase-Booker
27. Carlow-Portage-Chequest
28. Haymond-Dockery-Moniteau
29. Fatima-Arbela-Vesser
30. Landes-Sparta-Excello
31. Seymour-Edina-Clarinda
32. Ladoga-Gara-Armstrong
34. Nodaway-Colo-Zook
35. Albaton-Onawa-Haynie
36. Gideon-Sharkey-Sikeston
37. Sharkey-Steele-Tunica
38. Amagon-Dundee-Sharkey
39. Hayti-Portageville-Crevasse
40. Commerce-Sharkey-Fluvaquents
41. Scoto-Clana-Malden
42. Bosket-Malden-Broseley
43. Lilbourn-Wardell-Dundee
44. Scotco-Clana-Malden
45. Memphis-Loring-Falaya
46. Falaya-Adler-Zachary
47. Foley-Jackport-Crowley
48. Dundee-Sharkey-Bosket
49. Tuckerman-Bosket-Amagon
50. Captina-Clarksville-Macedonia
51. Clarksville-Wilderness-Captina
52. Gepp-Doniphan-Agnos
53. Clarksville-Goss-Doniphan
54. Urban Land-Harvester-Fishpot
55. Menfro-Winfield-Haymand
56. Menfro-Clarksville-Haymond
57. Lily-Minnith-Jonca
58. Haymond-Wilbur-Freeburg
59. Loring-Poynor-Weingarten
60. Goss-Pembroke-Union
61. Irondale-Killarney-Delassus
62. Bucklick-Caneyville-Gatewood
63. Crider-Fourche-Bucklick
64. Wilderness-Lebanon-Union
65. Haynie-Waldron-Blake
66. Viration-Scholten-Tonti
67. Hoberg-Keeno-Creldon
68. Clarksville-Noark-Nixa
69. Huntington-Nolin-Peridge
70. Creldon-Gerald-Eldon
71. Eldorado-Newtonia-Wanda
72. Creldon-Parsons-Carytown
73. Parsons-Kenoma-Dennis
74. Barco-Barden-Collinsville
75. Kanima-Parsons-Barden
76. Hector-Bolivar-Mandeville
77. Osage-Verdigris-Lanton
78. Zaar-Lula-Clareson
79. Hartwell-Kenoma-Deepwater
80. Sampsel-Polo-Snead
81. Summit-Eram-Catoosa
82. Macksburg-Marshall-Grundy
83. Bardley-Goss-Gasconade
84. Bardley-Goss-Doniphan
85. Pembroke-Eldon-Creldon
86. Arkana-Moko-Gassville
87. Viration-Clarksville-Lebanon
88. Nixa-Coulstone-Clarksville
89. Lebanon-Yelton-Viburnum
90. Union-Plato-Viration
91. Mano-Ocie-Britwater
92. Dockery-Zook-Blackoar
93. Parsons-Barden-Dennis
94. Hildebrecht-Weingarten-Goss
95. Lebanon-Gatewood-Beemont
96. Pershing-Greenton-Dockery
97. Paintbrush-Maplewood-Friendly
98. Union-Beemont-Hobson
99. Goss-Coulstone-Hobson
100. Glensted-Gerald
101. Midco-Secesh-Viration
102. Clarksville-Nixa-Captina
103. Brockwell-Boden-Portia
104. Falaya-Commerce-Fountain
105. Kobel-Commerce-Dubbs
106. Sharkey-Alligator-Tunica
107. Craig-Eldorado-Dennis
W. Open Water



Presettlement Distribution of Prairie & Pine
and Ecological Subsections of Missouri

Source: Schroeder, 1981b, Liming, 1946

Ozark Highlands hillslopes are formed in residuum from cherty dolomite and have red cherty loam and clay subsoils; and alfisols on many Ozark Highlands ridges have root-restricting fragipans in the subsoil.

Ultisols are prevalent in the Ozark Highlands Section. These soils look similar to alfisols but are very low in soluble bases. Alfisols and ultisols can often be distinguished by the geologic strata from which they formed, with ultisols having formed in strata that have been exposed to weathering and leaching for a longer period of time.

Floodplains in the various alluvial plains subsections are dominated by entisols and, to a lesser extent, inceptisols. The recently deposited alluvial sediments in which entisols form have not developed subsoils. Many retain the textural and color stratification of the original flood-deposited materials. Inceptisols are generally found on more stable, higher positions and have developed soil structure in the subsoil. Soil texture is highly variable among Missouri floodplain entisols, depending on the floodplain landform. For example, soils in splay deposits are typically sandy, soils on natural levees are typically loamy, and back-swamp soils are typically clayey.

HISTORIC VEGETATION

Missouri occupies a central continental position that lies between the great grassland biome to the west and the great forest biome to the east. Thus, during the last few thousand years of postglacial climate fluctuations (which apparently are still continuing), Missouri has experienced the invasion and retreat of different species and plant associations from east and west and from north and south, which has resulted in an extremely rich biological diversity.

Simplistic division of natural vegetation between grassland and forest is not at all adequate for Missouri. Although major portions of Missouri were either pure grassland or completely canopied forest at the beginning of the nineteenth century, it is becoming clear that much, if not most, of Missouri was a complex mixture of grassland(prairie), savanna, woodland and forest. The descriptions of ecoregions in this atlas recognizes these four categories.

Prairies in the early nineteenth century, before extensive Euro-American settlement, or "presettlement" time, occupied about a third of the state. The broadest prairies were in the Osage Plains of west-central Missouri and in the Grand Prairie centering on Audrain County in northeastern Missouri. Prairies occurred both as upland prairies and as wet prairies on the wide alluvial plains along rivers. Elsewhere in northern Missouri, prairies existed in smaller tracts, interlaced with strips of timber in stream valleys and on steeper slopes in tracts of rougher land. The pattern was an intricate geographical mosaic of timber and grass, with exceptional length of "edge," or boundary between the two. The intricate mosaic and associated edge significantly affected the types and numbers of wildlife in presettlement northern Missouri. It appears that just before Euro-American settlement of western and northern Missouri, timber was encroaching on grasslands because Indian use of the land was decreasing and the practice of burning prairies was waning, and because the climate was getting wetter and cooler. The most appropriate terms for these numerous places of tree expansion onto grasslands would be *woodland* and *savanna.* Oak forests occurred in the hills and blufflands along the Missouri and Mississippi Rivers in northern Missouri, except in northwestern Missouri, where midgrass prairies occupied the deep-loess blufflands.

The presettlement vegetation of the Ozarks included true forests, woodland, savanna, and significant prairie tracts. Forests dominated the thoroughly dissected

hills of the Current, Black, St. Francis, Meramec, and Gasconade River basins of the eastern Ozarks and the roughest lands of the White and Elk River basins of the southwestern Ozarks. Although oaks dominated these forests, pine was a codominant, especially in the Current and upper Gasconade and Meramec basins, where it also occurred in nearly pure stands generally associated with sandy soils, and in the White and Elk River regions *(see pg. 20)*. Woodland, however, prevailed throughout most of the central and western Ozarks, especially in areas of less relief. In many places it opened into tracts properly called savanna, as in karst uplands in Howell and Laclede Counties. Oaks dominated the Ozark woodlands as well as the forests. Glades, a special vegetative type of cedars and oaks among grasses on thin soil mostly over dolomite, occurred across the Ozarks but were most prevalent in the White River region. Prairies, small in extent but nevertheless true grasslands, occurred in the outer belts of the Ozarks, where they represented lands transitional to the surrounding more extensive prairies. They characterized the smooth uplands of the Springfield Plain and the western Ozarks in general as far north as the Missouri River. They also occurred on the loess-mantled karst plains in counties bordering the Mississippi River, and on the flatter uplands of the eastern Ozarks.

The southeastern lowlands contained what was by far the densest historic forest of Missouri. It had the tallest trees and the greatest variety and produced the greatest biomass. Much of the forest grew in land seasonally or perennially wet and has been termed a "swamp forest," but major areas consisted of upland deciduous forest dominated by oak. Minor areas associated with sandy ridges supported prairie and oak savanna. This region of Missouri contained a substantial number of plants and animals associated with the subtropical forests of the lower Mississippi River valley. Of all the regions of Missouri, the southeastern lowlands has lost the greatest part of its historic vegetative cover. Only a few remnants of the nineteenth-century forest cover remain.

CURRENT LAND COVER

The current land cover of Missouri is the result of several thousand years of both continuous natural processes and human activities. Natural processes include long-term climate change, short-term climate change (e.g., significantly wet or dry years), and climate "disturbances" (e.g., sustained, heavy rains that produce exceptional floods; tornadoes; severe droughts that produce natural fires or explosions of insect populations). However, human activities have changed the vegetative cover more thoroughly geographically and probably more intensively locally, especially since Euro-American settlement. Human activities range from burning grasslands and woodlands over centuries of time and the introduction of "exotic" plants from other continental and foreign locations, to much more obvious activities as conversion of native vegetation to farmlands of crops and pastures and for urban and transportation land uses.

The land-cover map of Missouri shows intense fragmentation of the surface into small tracts *(see pg. 22)*. Striking differences in current land cover are often separated by sharp boundaries commonly associated with land ownership or management. Current land cover is as much the result of division of the land into properties as it is the product of natural environment conditions.

Northern Missouri began to be extensively cleared for farms shortly after statehood in the 1820s in the counties along the Missouri and Mississippi Rivers. Land clearing reached the Iowa line in the 1840s; by the end of the century, most of northern Missouri was in farms, and the rural population was at its historic maximum. In the 1930s, as a result of the Depression, eroded land, farm mechanization, and changes in marketing, farmland began to be abandoned. Marginal cropland became pasture or woodland, and marginal pastures became woodland. Thus the general land cover today, which is a complex mixture of cropland on smoother surfaces and better soils, pasture on irregular surfaces and eroded soils, and woods on steeper slopes and rougher tracts, hides the fact that much more of the land was cropped and severely eroded a century ago. Much of northern Missouri has more land in trees and invasive timber in woodlands than it had a century ago and possibly even in the early nineteenth century, although the pattern is much more fragmented. Native prairies are rare; grasslands are represented by fescue pastures. The blufflands along the Missouri and Mississippi Rivers, and other tracts of rougher land, show up on the land-cover map as "forested," but most is second-growth forest with extensive past grazing influences.

The Osage Plains of west-central Missouri have experienced a similar history of land use. Conversion of the prairies to cropland occurred two or three decades later, generally after the Civil War. In fact, virgin prairies were still being plowed in the 1920s. In the first decades of the twentieth century, land-drainage districts converted many wetlands along streams into cropland. In general, there has been relatively less cropland loss in west-central Missouri in the last half century than in northern Missouri. Thus, the amount of invasive timber in woodlands is less, and the land cover remains more open in pastures and cropland. More native prairie remains in west-central Missouri than anywhere else in the state.

The land cover of the Ozarks shows two distinct subregions. The western Ozarks (except for the Osage basin and the White River country) has considerably more cropland and pasture than the eastern Ozarks, which is more forested. Less-dissected land, somewhat better soils, and natural prairies and woodlands led to a more complete settlement in the western Ozarks, with farms having cropland, pasture, and woodlots. The region around Springfield has the greatest concentration of cattle in Missouri, both dairy and beef cattle. Mainly second growth woodlands and forests dominate the hills and breaks along major rivers of the western Ozarks.

The eastern Ozarks, the Gasconade and Osage river hills, and the White River country are the most thoroughly forested regions of Missouri. However, their forested status today belies the fact that much of their tree cover was cut down during the lumber days of the first decades of the twentieth century or was cleared to establish hill farms. Failure of traditional, subsistence "patch" agriculture in the Ozarks has resulted in the return of much of the farmland to timber or wooded pasture. Cropland and improved pasture exist today basically only in the narrow alluvial bottoms of Ozark streams and flatter uplands. Thus the forest is essentially a second-growth forest, well managed in some areas and unmanaged in most areas. Fire suppression has likely produced a forest that is denser than the woodlands of the early nineteenth century. Extensive efforts over a half century have restored pine to many regions in the eastern Ozarks.

The most thoroughly agricultural region of Missouri is the southeastern lowlands. Almost 95 percent (excluding Crowley's Ridge) is in farms, and almost all of those are in croplands—very little land is in pasture. Remnants of the lowland forest that once covered the region occur in small, managed tracts and in locations without levees to protect them from flooding.

The alluvial plains along the Mississippi and Missouri Rivers stand out on the map of current land cover. Most of the leveed bottomlands are highly productive croplands, although since the Great Flood of 1993, several sizable alluvial tracts have been converted to managed wetlands.

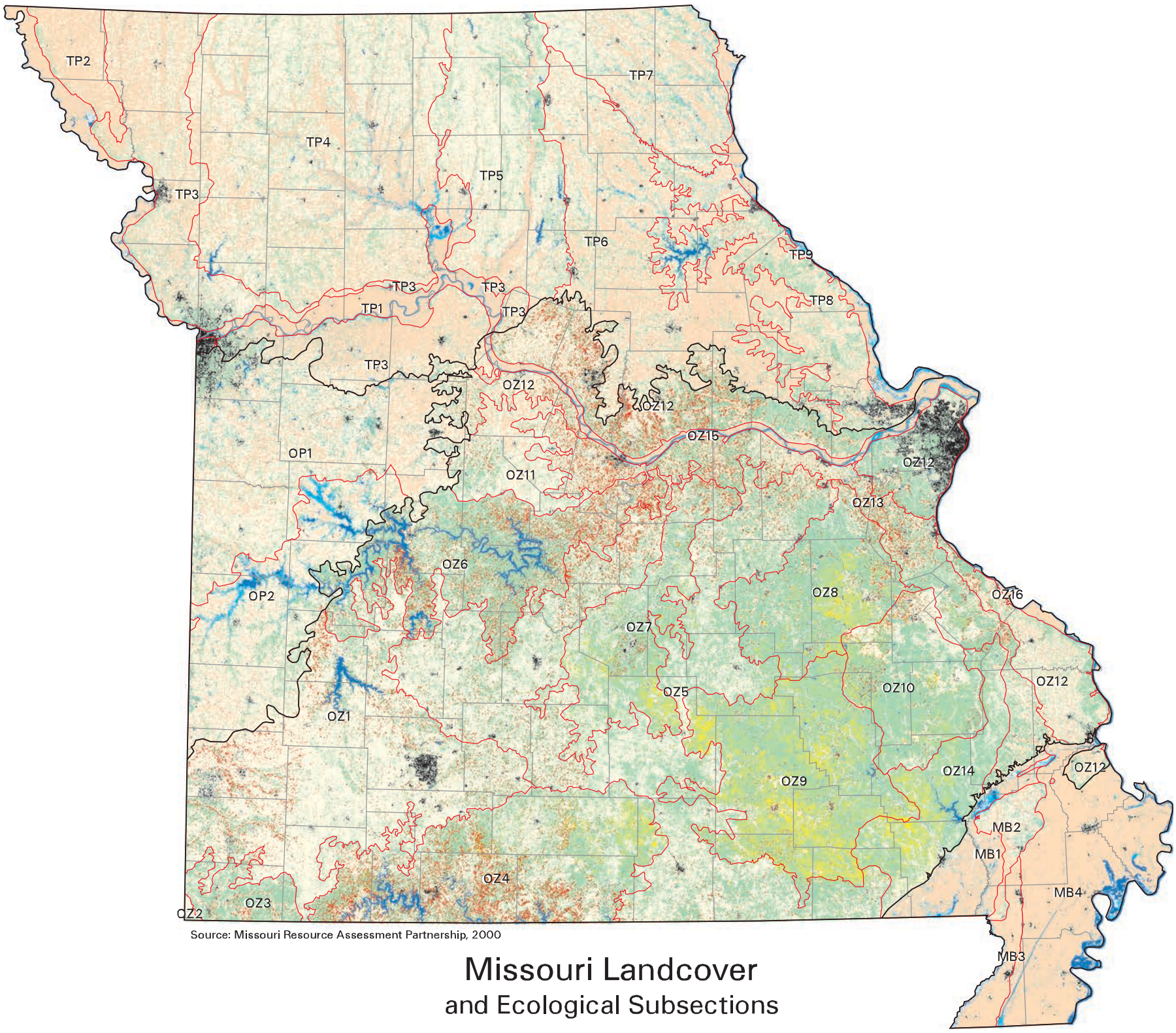
Urban land uses occupy an ever-increasing portion of the surface of Missouri. The urbanized land of the St. Louis and Kansas City metropolitan areas extends into eight and five Missouri counties, respectively. Other officially designated metropolitan areas in Missouri cover eight more counties. Smaller cities and towns cover significant areas, although fragmented and dispersed. The spreading out of urban populations to create lower population densities has the effect of allowing more plant cover within urbanized areas. Most towns and cities, especially in residential areas, have more trees and parkland than in the past, allowing more opportunities for the spread of plants and animals into them. Nevertheless, urbanization changes the landscape in semipermanent ways, such as introducing extensive impermeable surfaces that decrease infiltration of water into the ground and increase runoff, with a resulting degradation of water quality, and in long-term, subtle ways, such as increasing air temperatures and changing the nature of precipitation.

In rural regions, major transportation corridors affect natural processes and invite economic development. Highways serve as corridors for the invasion of exotic species and fragment the natural landscapes.

Large lakes also invite economic development. The Lake of the Ozarks and the Table Rock Lake–Branson areas become the equivalent of small metropolitan areas during summers. Smaller lakes have proportionately smaller developments, but they often occur within otherwise sparsely populated, relatively "natural" areas; thus, seasonal population increases have a noticeable affect on local ecosystems.

Gary Reese

Much of the estimated 200,000 acres of remaining prairie in the Osage Plains owes its survival to their value as prairie hay meadows.



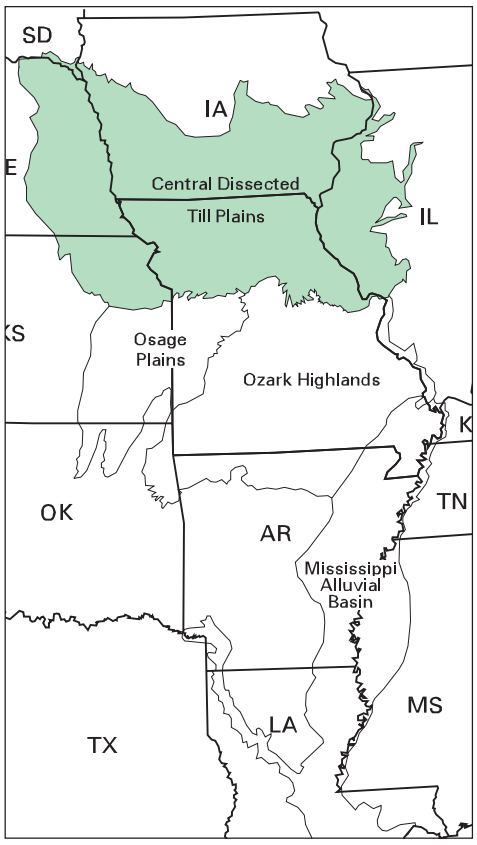
Source: Missouri Resource Assessment Partnership, 2000

Missouri Landcover
and Ecological Subsections

- Wetlands
- Open Water
- Urban
- Cropland
- Grassland
- Upland Deciduous Forest and Woodland
- Shortleaf Pine and Pine-Oak Forest and Woodland
- Bottomland Deciduous Forest and Woodland
- Eastern Redcedar and Redcedar-Deciduous Forest, Woodland, and Glade Complex

Source: Missouri Resource Assessment Partnership, 2000

TP Central Dissected Till Plains Section



The Central Dissected Till Plains Section is characterized by moderately dissected glaciated plains that slope regionally toward the Missouri and Mississippi Rivers. The section covers almost all of Missouri north of the Missouri River and extends into southern Iowa and portions of Kansas, Nebraska, and Illinois. In Missouri, the ecoregion is blanketed with Pleistocene loess over glacial till that varies in thickness from complete absence in peripheral regions to over three hundred feet thick in northern Missouri. The till was deposited by Pre-Illinoisan ice sheets over four hundred thousand years ago. Subsequent loess deposition, fluvial processes, and long-term weathering of surface materials make this region in many respects less a glacial landscape than a fluvial landscape. Except for the till, few recognizable glacial features remain.

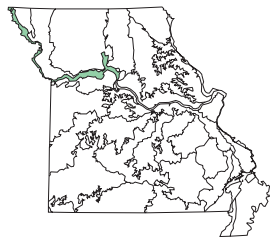
Millennia of fluvial erosion, transport, deposition, and pedologic processes have created a diversity of landforms that vary in degree of relief, dissection, and geologic parent materials and complex patterns of soil and natural vegetation. Smooth plains and broad ridges occupy areas distant from major drainages. They tend to have very deep, dark mollisols derived from loess under native prairie and claypan soils on the flattest uplands. Rolling hills with gentle slopes, closer to drainages, have a mixture of loess and till-derived soils, with prairie soils higher in the landscape and transitional savanna or woodland soils (thin mollic surface over an alfisol) on the sideslopes. More highly dissected lands, with narrow ridges and deep valleys, occur near the major drainages, especially the Missouri and Mississippi Rivers. In these places the ridgetops may carry deep loess caps, but residual soils from sedimentary bedrock occur on the steep sideslopes. These areas have transitional soils high in the landscape and true forest soils low in the landscape. The major tributaries to the Missouri and Mississippi Rivers, especially the Grand and Chariton Rivers, occupy exceptionally broad and flat valleys. Most of these channels have been straightened by channelization. Bottomland soils vary from well-drained forest soils to poorly drained wetland soils. In general, the rather complete dissection of the Central Dissected Till Plains has resulted in an intricate mosaic of uplands, sideslopes, and bottomlands, with an equally complex pattern of potential prairie, woodland, and forest ecosystems.

Rick Thom

Differences in landform, geology (including till and loess), soils, and vegetation produce nineteen ecological subsections, nine of them in Missouri. Subsections include flat alluvial plains associated with the Missouri and Mississippi Rivers; deep-loess hills along the Missouri River; high, flat prairie plains; and thoroughly dissected, steep-sided, timbered hills. Each subsection has a unique set of attributes that gives it a particular set of conservation challenges and opportunities. The subsections are further subdivided into landtype associations or ecological landscapes of a few hundred square miles that are based on local variations in the biophysical pattern. The subsections and landtype associations within the Central Dissected Till Plains Section are described on the following pages.

TP1
MISSOURI RIVER ALLUVIAL PLAIN SUBSECTION

(see maps pgs. 58–61)



GENERAL DESCRIPTION

The subsection consists of the alluvial plain and channel of the Missouri River and the lower Grand River from the northwestern corner of the state downstream to near Glasgow. The plain is broader and has a higher proportion of fine-textured, poorly drained soils than the Missouri River alluvial plain within the Ozark Highlands. Presettlement natural vegetation was largely wet prairie and marshes, with narrow bands and isolated pockets of bottomland forest. The Missouri River channel, which formerly meandered, has been stabilized, narrowed, leveed, and is now mostly island-free. The subsection is devoted mainly to cropland. The Kansas City and St. Joseph metropolitan areas exert urbanization pressure on land use on the alluvial plain.

LOCATION AND BOUNDARIES

This subsection extends for 220 miles from the northwestern corner of the state along the Missouri River to central Missouri. It averages only a few miles wide, but in some places reaches 10 miles in width. Its boundaries are marked by conspicuous bluff lines of the adjacent loess hills. A portion of this alluvial plain extends up the broad valley of the Grand River in central Missouri. The subsection continues into Kansas, Iowa, Nebraska, and South Dakota.

CLIMATE

Mean annual precipitation ranges from 34 inches in the northwest to 39 inches in the southeast. At Oregon in the northwest, the wettest months are May–September, and an impressive 72 percent of the annual precipitation occurs during the six warmer months of the year. At Brunswick in the southeast, the comparable data are April–October and 64 percent. Annual snowfall ranges from 25 inches in the northwest to 19 inches in the southeast. Mean January minimum daily temperature ranges from 12° in the northwest to 17° in the southeast. Mean July maximum daily temperature is 89–90°. The growing season averages 200–208 days. Microclimatic variations are not significant except over and adjacent to the river surface. Fog often forms in spring and fall due to temperature differences between the water and overlying air.

TOPOGRAPHY AND GEOLOGY

The subsection consists of the channels and alluvial plains of the Missouri and lower Grand Rivers. Bedrock is usually more than 30 feet below the surface. The alluvial fill consists primarily of Pleistocene and Holocene gravels, sands, and silts transported from glaciated regions to the north, overlaid by Recent alluvium. Surficial materials are sandy and silty and were formerly reworked by the meandering Missouri River approximately once every 150 years. As a result, surficial materials, including soils, are generally not more than 150 years old. Those channel shifts have now been halted by channel stabilization works. Relief on the alluvial plain is generally less than 10 feet in any square mile, including low escarpments of alluvial terraces formed as the result of channel shifts. The reaches from the Iowa border to St. Joseph and from Kansas City to Glasgow are reaches that existed in pre-Pleistocene time. The reach from St. Joseph to Kansas City was created during or after glaciations of the Pleistocene. The notably broader alluvial plain between Levasy and Dewitt is explained by the less resistant Pennsylvanian shales into which the valley is carved in that reach. Most of the alluvial plain has been drained and is protected by levees, but significant "natural" tracts remain in a few places, especially along the Grand River.

SOILS

Soils in this subsection are all very deep and were formed in alluvial sediments. Subsoil development is minimal in these relatively youthful soils, and textural stratification within the soil profile is common. Soil texture and drainage vary, depending on the position within the alluvial plain. Sandy soils, such as the excessively drained Sarpy series, occur in splay deposits near the river. Clayey soils, such as the poorly drained Albaton and Waldron series, are in back swamp or slack water positions farther from the river. Silty soils, such as the well-drained Haynie series, are on natural levees. However, due to the shifting river channel, the relationships between soils and river location may not be apparent. Some soils have strongly contrasting textures within the soil profile, reflecting changes in river position. For example, Onawa soils are clayey in the upper part, and silty in the lower part. Alluvial sediments deposited by the Missouri River are calcareous, and therefore soils in the Missouri River alluvial plain have free carbonate rocks within the profile, with neutral to slightly alkaline pH values. In contrast, soils in the Grand River alluvial plain are neutral to strongly acidic, with no free carbonate rocks.

HYDROLOGY

The subsection contains the channel of the Missouri River from the Iowa state line to southeastern Saline County and streams and drainage channels from the adjacent bottomlands. As a natural river, the Missouri formerly shifted its channel and regularly translocated its islands and bars in a morphologically very dynamic environment. Since the mid-twentieth century, channel banks have been stabilized, although subsurface bed forms continuously change. The channel has been narrowed to approximately one-half of its former width, most islands have been eliminated, and the channel has been deepened. The bed and banks are sandy, silty, and clayey and have a significant gravel fraction. The Kansas River and Grand River contribute enormous amounts of silt to the Missouri River, especially during high discharges. The Missouri River carries a high suspended load of silts and clays and reasonably high bed loads of sands and small gravels. River depth reaches over 20 feet in selected spots below Kansas City. A 9-foot-deep navigation channel is maintained. The river drops about 0.9 feet per mile in this subsection. Average discharge is 41,000 cubic feet per second at St. Joseph and 50,500 cubic feet per second at Waverly. Average discharge of the river in its former natural state was six times greater in June (maximum) than in January (minimum). Discharge is now regulated by many large dams and reservoirs upstream on the Missouri and its tributaries, and the range in average monthly flows is much reduced. Most of the river floods are held back by levees, but the height and strength of the levees are not standardized. Some bottoms are not protected and flood much more frequently than others. Occasional high-magnitude events submerge levee-protected bottoms and cause major changes in the landscape. High discharges also significantly scour the channel bed and modify channel geometry, even if banks remain reasonably stable. Very low discharges are also possible, but they are not as common or extreme as before stream regulation. Icing may affect fluvial processes in midwinter. The bottoms were formerly wet in many places in former sloughs and oxbows, but most have been drained. A few wetlands and oxbow lakes remain and others have been restored, especially in the lower Grand River alluvial plain. Water levels in the lower courses (mouths) of tributaries are controlled by stages of the Missouri River and usually constitute a quiet, backwater fluvial environment that contrasts with the "open" channel of the fast-flowing Missouri River. Water quality is low, but it is better than it has recently been. Much point-source pollution has been eliminated, but some remains in mixing zones downstream from outfalls. Significant non-point-source pollution remains, and most of it enters the river from tributaries.

Wetlands, like these at Squaw Creek National Wildlife Refuge, were once common on the upper Missouri River.

Jim Rathert

TERRESTRIAL NATURAL COMMUNITIES

Historic. The river formerly flowed in a braided channel with numerous islands, side chutes, and backwaters. Nearly annual flooding created a complex and shifting mosaic of bottomland forest, marshes, wet prairies, and sandbars. Large portions of the bottoms were formerly open prairie and marsh complexes. Large sandbars with willow and cottonwood thickets were also common. Timber was largely composed of riverfront species including willow, cottonwood, silver maple, elm, hackberry, and ash. Mixed-hardwood forests with a strong oak component were associated with higher, better drained, and less disturbed terraces. The heavily silt-laden river supported a variety of aquatic organisms tolerant of its conditions.

Current. Extensive draining, bank stabilization, and leveeing has drastically altered the hydrology. Most of the islands are gone and most of the major bottoms are now cropland. While most wetlands have been drained, there are a substantial number remaining, many of which are in conservation ownership or wetland reserve programs; the number of these have increased substantially since the Great Flood of 1993. Public ownership of land in the subsection is scattered but substantial. Concentrations of natural communities and managed wetlands occur north of St. Joseph and along the lower Grand River.

Major Natural Community Types

Central Cordgrass Wet Prairie

Freshwater Marshes

Riverine Sand Flats

Sycamore, Cottonwood–Black Willow Riverfront Forest

Southern Green Ash, Elm, Sugarberry Riverfront Forest

Pin Oak–Mixed Hardwood Wet Bottomland Forest

Red Oak, Sugar Maple, Bitternut Hickory Mesic Bottomland Forest

Rare or Restricted Natural Communities. The assemblage of aquatic life in the Missouri River was adapted to its silty and dynamic character, but radical alteration of the aquatic environment has completely changed it. While most bottomlands have been drained and cleared, some low wet areas continue to support remnant terrestrial communities. Quality wet prairies and marshes occur but are very rare. Bottomland forest is even more rare. Several unique fen communities persist.

NATURAL DISTURBANCES

Flooding created a dynamic cycle of wetland destruction and creation that resulted in a highly diverse ecosystem. Drought and freezing also played important roles in shaping the hydrology of the ecosystems. Agricultural activities by Native Americans, including the use of fire, helped shape the bottomland prairies.

Abundant waterfowl, like these snow geese, depend on wetlands along the Missouri River flyway.

Jim Rathert

RARE OR ENDANGERED SPECIES

The Missouri River Alluvial Plain Subsection contains more than 160 records of 73 state-listed species, a large majority of which are fish, mussels, birds, and plants associated with the river and wetlands along it. Two species of federal concern are the bald eagle *(Heliaeetus leucocephalus)* and pallid sturgeon *(Scaphirhynchus albus).* Eight species have their occurrence in Missouri restricted to this subsection.

NATURAL AREAS

The subsection has only two designated Natural Areas. Yellow Creek contains outstanding bottomland forest, and Little Bean Marsh is a significant natural marsh.

PUBLIC LANDS

The subsection has more than 45,000 acres of public land. The Missouri Department of Conservation manages more than 18,000 acres, including Bob Brown, Cooley Lake, Deroin Bend, Fountain Grove, Grand Pass, Lower Hamburg Bend, and Swan Lake Conservation Areas. The U.S. Fish and Wildlife Service manages more than 20,000 acres at Squaw Creek and Swan Lake National Wildlife Refuges. There are three state parks: Big Lake, Lewis and Clark, and Pershing. Though not public lands, numerous historic sites along the river commemorate the Lewis and Clark expedition of 1804–1806.

HUMAN GEOGRAPHY

Demographics. The subsection was a major corridor of movement for Indians of various nations and tribes. Indians continued to use the river to get to and from St. Louis well into the nineteenth century. Indian occupation of the alluvial plain was done in conjunction with settlements in the adjacent blufflands, as at Van Meter State Park. French also used the river as a corridor of movement for several decades. They established Fort Orleans near the mouth of the Grand River in 1723. Americans also used the river for transit, beginning in the early 1800s. Steamboats became common in the 1820s and peaked in the decades after the Civil War. Settlements were established in a few places as river landings, but, in general, the alluvial lands were not widely cleared and farmed until after the adjacent blufflands were. Settlement on the alluvial plain began in the 1820s in central Missouri and reached northwestern Missouri in the 1840s. The people who settled the subsection were a wide variety of old-stock Americans from eastern states. In general the rural population has been declining rapidly in the last half of the twentieth century. Many residences have been removed from flood-prone locations, although the amount of farmland has not been reduced substantially.

Economics and Land Use. By the beginning of the twentieth century most of the timber was cleared and the land put into cropland. Levees, made higher and stronger as the century progressed, help to protect farmland against all but the highest floods. The economy is largely agricultural. Most of the land is used for farms, chiefly crops of soybeans, corn, and wheat. A much smaller amount is used for pasture. Timber remains along the riverbanks and in wetter places, such as new land created by channel engineering that narrowed the channel and land unprotected by levees. Commercial and industrial activities are intense on the alluvial plain in the Kansas City and St. Joseph metropolitan areas.

LANDTYPE ASSOCIATIONS

The Missouri River Alluvial Plain Subsection is subdivided into four landtype associations (LTAs). Recognition of these four LTAs is based on differences in valley width, soil textures, and historic vegetation. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Missouri River Alluvial Plain, like most large alluvial plains in the state, has been severely altered by channelization, drainage, and conversion to agriculture. Dams on the upper Missouri have radically altered the hydrologic regime. Hydrologic conditions crucial for some aquatic life are gone, and limited natural vegetation remains. Acquisition and management efforts, however, are illustrating the resiliency of this ecosystem. Allowing some conservation lands to serve for flood storage during high water and emulating more closely the natural hydrograph in river management will promote native species and ecosystems. Finding ways for agriculture and native ecosystems to coexist in the alluvial plain will be key to future conservation success. Finally, minimizing pollution from developing urban and industrial areas along the river will be a challenge.

(see landtype associations maps pgs. 58–61)

LANDTYPE ASSOCIATIONS IN THE MISSOURI RIVER ALLUVIAL PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP1a Northwest Missouri River Alluvial Plain	The LTA occupies the broad alluvial plain of the Missouri River from the Iowa line downstream to Mound City in Holt County. Boundaries are the river channel and the bluff line. The downstream boundary is placed where the plain narrows abruptly.	The LTA consists of an unusually broad portion of the alluvial plain within Missouri, containing numerous wetlands and former channels of the Missouri River and tributaries in various stages of being filled in. Historically the LTA was covered in extensive bottomland prairie and marshlands with belts of timber mainly along the rivers. Soils are somewhat finer textured and more poorly drained than in reaches farther downstream. Today the landscape is primarily productive cropland with several significant wetland complexes, including Squaw Creek National Wildlife Refuge and vicinity.
TP1b Western Missouri River Alluvial Plain	The LTA occupies the narrow portion of the Missouri River alluvial plain from Mound City in Holt County downstream past Kansas City to Camden in south-central Ray County. Its boundaries on both ends are where the plain broadens abruptly.	The LTA consists of a narrow alluvial plain (0–4 miles wide) with numerous oxbows and swales of former channel locations. Three engineered cutoffs of meanders are at St. Joseph, Liberty-Courtney, and Sibley. This reach of the alluvial plain is distinguished for having small amounts of wet prairie historically and more extensive timberlands. Today, it is almost entirely cropland and extensive urban and industrial development at St. Joseph and Kansas City. Small state parks and conservation lands are in the LTA.
TP1c Wakenda Missouri River Alluvial Plain	The LTA occupies a broad reach of Missouri River alluvial plain between Camden in Ray County and the mouth of the Grand River.	The LTA consists of an exceptionally broad bottom enclosed by low bluffs mostly in Pennsylvanian shales. Wakenda Creek flows for 25 miles on the alluvial plain parallel to the channel of the Missouri River before joining it at Miami. The plain has several prominent scour holes, or "blue holes," created by the 1993 flood. The LTA includes the Tetesaw (Petits Osages) Flats, a large Pleistocene terrace below Malta Bend that drains away from the Missouri River. Unique fens and seeps occur on the Tetesaw Flats. Historically the whole LTA was dominated by wet prairie and marshland. Poorly drained soils on the northern side of the river formerly supported one of the most extensive bottomland prairies on the Missouri River. Today the region is in productive, levee-protected cropland with two publicly owned wetland conservation areas.
TP1d Missouri-Grand River Alluvial Plain	The LTA occupies the alluvial plain of the lower Grand River below Locust Creek in extreme northwestern Chariton County and the alluvial plain of the Missouri River from the Grand River confluence downstream to near Glasgow. Boundaries are placed where the plains narrow abruptly.	The LTA consists of moderately broad alluvial plains with local relief of 10–20 feet that are subject to frequent and intense flooding at the confluence of the Grand and Missouri Rivers. The plain has numerous oxbows and other remnants of former channels. Several terraces, some with colluvial wash, stand out prominently. Historically, wet prairie dominated the Grand River plain and major portions of the Missouri River plain; the rest of the bottoms was bottomland forest and marsh. Though cropland dominates today, there are substantial wetland acres associated with Fountain Grove Conservation Area, Swan Lake National Wildlife Refuge, and surrounding private lands in the Grand River sector.

TP2
DEEP LOESS HILLS SUBSECTION

(see map pgs. 58–59)

GENERAL DESCRIPTION

The Deep Loess Hills Subsection is distinguished by moderately thick to very thick loess (25 to 100 feet, possibly more) over till and bedrock that has been eroded into steep hills and narrow valleys with up to 250 feet of relief. Loess has been redeposited at lower positions in the landscape as colluvium and alluvium. Underlying glacial till and bedrock are not commonly exposed at the surface. Presettlement vegetation was nearly pure prairie with thin bands of timber in the valleys and ravines. The loess hill prairies bordering the steep slopes along the Missouri River have a unique composition with many mid- and short-grass prairie species reaching their eastern limits on the steep arid slopes. Most of the subsection is considered prime farmland, and sediment yields from heavy rains can be enormous.

LOCATION AND BOUNDARIES

The Deep Loess Hills Subsection lies in extreme northwestern Missouri. It comprises major portions of Atchison and Holt Counties and a very small portion of Nodaway County. Its western boundary is the sharp line of bluffs that rises above the Missouri River alluvial plain. The eastern boundary is based on the thinning of the loess cover. It is drawn, in principle, where the depth of loess on uplands thins to less than 25 feet. This is reflected in the landscape by a reduction of local relief and by a declining number and depth of erosional ravines. It also is reflected, in general, by the difference between Marshall soils of this subsection and Sharpsburg soils of the Loess Hills Subsection to the east. The subsection extends into Iowa, where it is much more extensive.

CLIMATE

Mean annual precipitation is 34–36 inches, very unequally distributed throughout the year. The wettest months are May–September. The average June precipitation is over five times greater than the average January precipitation and 71 percent of the annual precipitation occurs during the six warmer months of the year (at Tarkio). Annual snowfall averages 23–25 inches, the highest in Missouri. Mean January minimum daily temperature is 12–13°, the lowest in Missouri. Mean July maximum daily temperature is 89°. This region experiences the most pronounced continental effects on climate in Missouri. The growing season averages under 200 days, although it can be greatly reduced by late spring freezes and early autumn freezes. Microclimatic variations, such as evaporation rates, are significant between steep southwest-facing and northeast-facing slopes.

TOPOGRAPHY AND GEOLOGY

The subsection is underlain by alternating shales and thin-bedded limestones of the late Pennsylvanian, but they are so deeply buried by glacial till and loess that they have little effect on surface features. Pre-Illinoisan glacial till is over 100 feet thick and also is usually not exposed. Late Pleistocene and Recent loess is over 25 feet thick (perhaps as thick as 100 feet in selected places) and is chiefly responsible for the surface features. Stream erosion has cut deep, steep-sided ravines and valleys into the silty and clayey-silt loess. Plowing the hillsides enhanced the natural erosional processes and produced enormous sediment yields. Valley bottoms are deeply alluviated from redeposited loess. Hillslope processes are some of the most dynamic in the state. Relief in the loess blufflands of Missouri is 150–250 feet and declines with distance from the Missouri River.

SOILS

Soils in this subsection are nearly all very deep, and most upland soils are well to moderately well drained. Most of the upland soils were formed entirely in Peorian-aged loess. Glacial till underlies this loess, and soils on lower backslopes in the central and eastern part of the subsection were formed in till, such as the Shelby series. The loess thins and the clay content increases from west to east. Except for a narrow strip of the forested, highly dissected Timula and Ida soils in the westernmost loess bluffs, the soils have formed under prairie vegetation and consequently have thick, dark surface layers. Timula and Ida soils are very deep silt loams, with thin surface layers, low clay content, and little or no subsoil development. Deep loess prairie soils include Monona, with silt loam throughout, and Marshall, with silty clay loam subsoils. The glacial till–derived Shelby soils have clay loam subsoils. Soils on footslope positions, such as the Judson and Napier series, have very thick surface layers. Floodplains are relatively narrow and inextensive, with very deep silty and clayey soils such as Colo and Zook.

HYDROLOGY

The subsection contains small streams tributary to the Missouri River, the largest of which is the Tarkio River. Most are now intermittent and ephemeral, but the larger ones are perennial with small discharges. Discharge is highest in spring and summer and lowest in fall and winter. High-intensity spring and summer rains frequently cause flash floods. Streams carry very high suspended sediment loads derived from the subsection's easily eroded loess soils. Channels are in silt. Some have been straightened by channelization, and this has thrown streams out of equilibrium and into channel degradation. Rilling and gullying on slopes is common. There are no natural ponds or lakes, and relatively few have been constructed for stock watering or other purposes. Ponds quickly fill up with silt and thus their life expectancy is short. Water quality is seriously affected by agricultural land use and high turbidity. Groundwater is deep below the surface and is saline.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The Deep Loess Hills ecoregion was primarily prairie, including unique dry loess hill prairies. Oak savanna occurred sparsely on protected slopes and in ravines.

Current. Today the region is over 75 percent cropland with scattered pasture. Remnants of dry loess hill prairies are common, albeit reduced in size on the steepest loess blufflands along the Missouri River. Ravines in the blufflands are often timbered in invasive species such as elm and hackberry, with scattered savanna trees.

Major Natural Community Types

Loess Hills Dry Prairie

Midwest Dry-Mesic Glaciated Prairie

Central Mesic Tallgrass Glaciated Prairie

Central Bur Oak Glaciated Dry-Mesic Savanna

Rare or Restricted Natural Communities. The unique dry loess hill prairies of the steep blufflands along the Missouri River have western mid- and short-grass prairie plant and animal species mixed with typical tallgrass species. These communities are endemic to these prairies here and north into Iowa. Mesic prairies on glacial materials are very rare; nearly all are cropland today. Intact savannas are also quite rare.

NATURAL DISTURBANCES

Fire and grazing would have created and maintained this grassland-dominated landscape. Drought would have added to restriction of tree species and the frequency of fire.

RARE OR ENDANGERED SPECIES

The Deep Loess Hills Subsection contains 217 records of 30 listed species. The majority of these species are associated with the dry loess hill prairies in the Missouri River blufflands. Eight species are found only in these localities in

Jim Rathert

Steep loess hills lining the Missouri River in northwestern Missouri support dry loess hill prairies with numerous unique species.

Missouri. The western prairie fringed orchid *(Platanthera praeclara)* is the only federally listed species known from the region.

NATURAL AREAS

The subsection has five designated Natural Areas. Star School Hill Prairie, McCormack Loess Mound, and Brickyard Hill Loess Mound all protect outstanding dry loess hill prairies. Tarkio and Little Tarkio Prairie represent mesic and dry-mesic glacial prairies once widespread in the region.

PUBLIC LANDS

The subsection has only 3,700 acres of public land. The Missouri Department of Conservation owns nearly all of this acreage, including the following Conservation Areas: Star School Hill Prairie, Tarkio Prairie, Brickyard Hill, Bilby Ranch Lake, Nodaway Valley, and Little Tarkio Prairie. The U.S. Fish and Wildlife Service owns a very small acreage as part of Squaw Creek National Wildlife Refuge.

HUMAN GEOGRAPHY

Demographics. Nodaway and other Indians lived and hunted in this subsection. Americans also hunted in the region, beginning in the 1820s, and began agricultural settlement in the 1830s and 1840s after the Platte Purchase area was annexed to the state of Missouri. Early farms were in valleys and had small fields and extensive livestock grazing on the prairies. These settlers were a mixture of Americans from eastern states, chiefly from states north of the Ohio River. Rural population reached its maximum in the early decades of the twentieth century and has been declining ever since. The rural areas have only about one-fourth of their former peak populations.

Economics and Land Use. After railroads came, agriculture was quickly commercialized and tended to emphasize hogs and corn, wheat, and other grains. By the first third of the twentieth century this had become one of the premier crop-growing regions of the state. Mechanization and other innovations caused a restructuring of farming, and the steepest lands and most eroded lands were taken out of row crops. Still, the amount of soil loss after rains, especially spring rains on bare soil, is exceptionally high. Agriculture is by far the economic mainstay, with crops and fallow croplands occupying all suitable land. Livestock is much less important than grains. Trees are on steep slopes, along streams, and in gullies. In some selected bluffland tracts, trees are prevented from establishing themselves by intentional burning of the land. The small towns of the subsection have developed very little commercial activity.

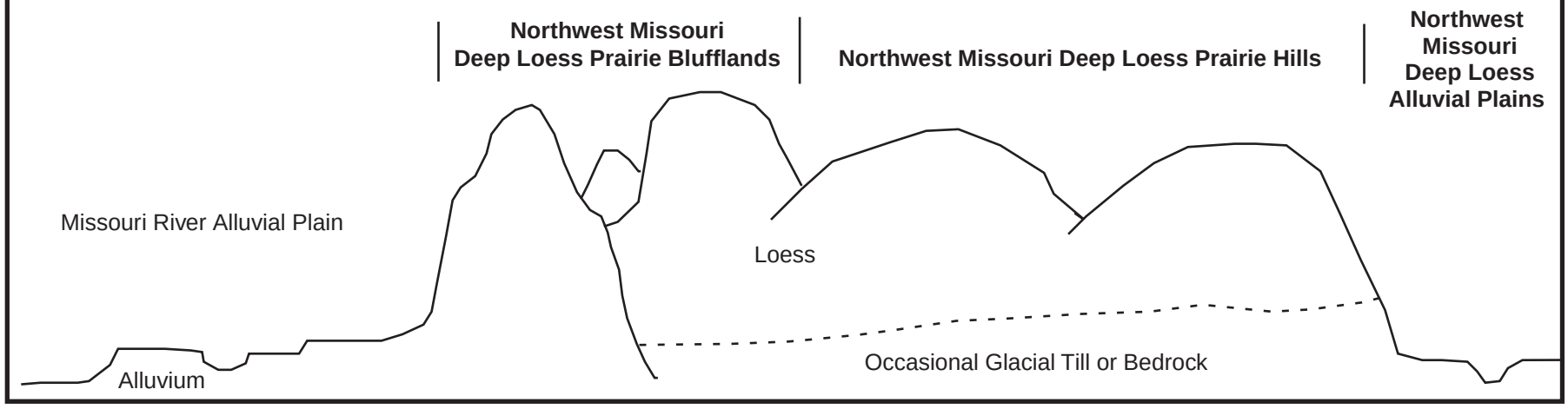
LANDTYPE ASSOCIATIONS

The Deep Loess Hills Subsection has been broken into three landtype associations (LTAs). These LTAs include broad, flat alluvial plains, very steep loess blufflands, and more rolling, deep loess hills. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The deep loess soils are highly erodible in the absence of good farming practices. Excessive erosion not only degrades the long-term productivity of the land but also sends massive amounts of sediments into streams. Fewer than 50 acres of native dry loess hill prairie remain and less than half of that is in conservation ownership. Few typical dry mesic and mesic loess prairie remnants are even known, and only two are in conservation ownership. A regional effort to conserve dry loess hill prairies and restore glacial prairie landscapes is needed.

LANDTYPE ASSOCIATIONS IN THE DEEP LOESS HILL SUBSECTION

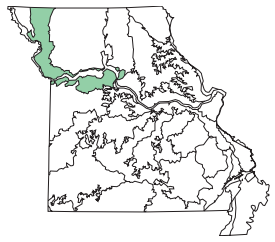


(see landtype associations map pgs. 58–59)

LANDTYPE ASSOCIATIONS IN THE DEEP LOESS HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP2a Northwest Missouri Deep Loess Alluvial Plains	The LTA occupies very limited segments of the alluvial plains along the Tarkio River where they are more than 1 mile wide.	The LTA consists of broad alluvial plains along the lower 18 miles of the Tarkio River. The surface is essentially flat, with deep alluvium that is well to somewhat poorly drained. Historically the LTA was prairie and wetlands and river-edge trees. Today it is nearly all cropland.
TP2b Northwest Missouri Deep Loess Prairie Blufflands	The LTA occupies a narrow band of very deep loess (more than 75 feet) eroded into steep bluffs and slopes along the bluffs of the Missouri River between the Iowa state line and Squaw Creek National Wildlife Refuge in Holt County. Boundaries are drawn to include steep and dissected hills dominated by Mona and Ida soils. The LTA extends far north into Iowa.	The LTA consists of a narrow band of very steep and rugged loess hills that constitute the Missouri River blufflands. Local relief averages 150–200 feet. The surface is highly eroded into excessively steep-sided, deep ravines or canyons, the sides of which often collapse in slump blocks. Small, isolated remnants of dry loess hill prairies have been shrunken by woody invasion, although prescribed fire is used to open them up. Some former prairie and savanna tracts have become dense timber or overgrazed pasture.
TP2c Northwest Missouri Deep Loess Prairie Hills	The LTA occupies much of the dissected uplands of Atchison and Holt Counties in northwestern Missouri. Boundaries are drawn to encompass exceptionally dissected hills on deep loess soils, especially the Marshall series. The western boundary excludes the very steep and dissected blufflands with Mona and Ida soils. The eastern boundary is mainly a drainage divide that coincides roughly with a change to shallower loess and Sharpsburg soils.	The LTA consists of intricately dissected, loess-covered hills with narrow ridges, steep slopes, and local relief of 100–150 feet. Loess is from 25 to more than 100 feet thick. Historically, the LTA was covered in prairie with small bands of timber confined to the deepest, V-shaped ravines and protected slopes. Today, the productive but highly erodible soils are more than 75 percent cropland with scattered pasture.

TP3
LOESS HILLS SUBSECTION

(see map pgs. 58–61)



GENERAL DESCRIPTION

The Loess Hills Subsection is distinguished by a thick loess mantle (10–25 feet) and loess soils. It is a hilly region characterized by broad, rounded ridges, moderate slopes, broad stream valleys, and a local relief of 100–150 feet. Bedrock and glacial till are exposed in the deeper valleys. Presettlement vegetation was mostly prairie with timber and brush in valleys and on steeper slopes. Most of the subsection is in farms, but substantial tracts in the breaks along the Missouri River are thickly wooded. Urbanization pressures are intense in the St. Joseph and Kansas City metropolitan areas.

LOCATION AND BOUNDARIES

This irregularly shaped subsection is associated with the Nodaway and Platte Rivers in northwestern Missouri, then along either side of the Missouri River from Kansas City into central Missouri. The subsection includes large portions of Nodaway, Andrew, Buchanan, Platte, Clay, Jackson, Lafayette, and Saline Counties. Small portions of seven counties are also included (Worth, Holt, DeKalb, Clinton, Ray, Carroll, Chariton, and Howard). The southern boundary with the Osage Plains Section is defined as a line that separates loess soils from residual soils derived from sedimentaries of the Osage Plains. This line has little expression in landscape relief. In a very general way, the line also expresses the southern limit of glaciation, although not all the land north of it has glacial deposits remaining and it may not have ever been glaciated. The northern and eastern boundaries are also defined on the basis of soils. Soils of this subsection are mainly loess-derived (Knox and Sharpsburg soils, for example), and soils to the north and east of the boundary are generally till-derived (Grundy and Shelby soils, for example). The boundary in the extreme northwest is based on depth of loess. To the west of the line loess is generally thicker than 25 feet and creates a deeply ravined landscape that is generally lacking in this subsection. The boundaries of this subsection with the Missouri River Alluvial Plain are defined as the bluff line of the alluvial plain. The Loess Hills Subsection extends northward far into Iowa and across the Missouri River into Kansas.

CLIMATE

Mean annual precipitation is 35–39 inches. At Maryville in the north, the wettest months are May–September, and an impressive 71 percent of the annual precipitation occurs during the six warmer months. The average June precipitation is seven times greater than the average January precipitation. At Marshall in the south, precipitation is not so unevenly distributed. The wettest months are May–June and September, and 64 percent of the annual precipitation occurs during the six warmer months. Annual snowfall averages 24 inches in the northwest and 19 inches in the southeast. Mean January minimum daily temperature ranges from 12° in the northwest to 17° in the southeast. Mean July maximum daily temperature is 88–90°. The growing season ranges from just under 200 days in the northwest to 208 days in the southeast. Microclimatic variations are significant in local areas of higher relief.

TOPOGRAPHY AND GEOLOGY

The subsection lies on the northwestern flank of the Ozark uplift in central Missouri and extends to the Forest City structural basin in northwestern Missouri. Strata generally dip northwestward throughout the region into that basin. Older, Mississippian formations underlie the subsection in central Missouri, and formations get progressively younger (Pennsylvanian) in a northwestward direction. The Mississippian formations are cherty limestones, and the Pennsylvanian formations are series of cyclical shales, thin-bedded limestones, sandstones, and coals. Bedrock crops out along the Missouri River bluffs and the lower courses of its tributaries. The limestones form prominent rock ledges and the shale forms gentler slopes between them. Where limestone is absent, slopes on the shales are gentle. In several places limestones form prominent shoals or rapids in stream channels. Pre-Illinoisan glacial till covers much of the region and obscures the bedrock. It is thickest and most extensive in northwestern Missouri but patchy along the Missouri River east of Kansas City where it is only 10–25 feet thick. Till is largely responsible for surface features away from the major stream valleys and in large part gives the subsection its topographic distinction. Pleistocene and Recent loess mantles both till and bedrock over the entire subsection, except where it has been removed by stream erosion. Local relief along the major stream valleys averages 150–250 feet, but away from them it is reduced to 100–150 feet and in smoother parts falls below 100 feet. Many valley bottoms, which often tend to be broader than expected from the size of the streams, were poorly drained before drainage districts were organized in the twentieth century. Coal was formerly mined by shaft and adits in Ray and Lafayette Counties. Very extensive underground mining for limestone in the Kansas City metropolitan area has created enormous mined-out spaces and has locally caused the surface to subside.

SOILS

Soils in this subsection are nearly all very deep. Most upland soils range from well to somewhat poorly drained. Upland soils on interfluves and upper backslopes were formed in Peorian-aged loess, whereas soils on lower backslopes formed in glacial till, such as the Shelby series. Knox soils in the loess bluffs formed under forest or savanna vegetation and have relatively thin silt loam surface layers over silty clay loam subsoils. Other deep-loess soils such as Sharpsburg, Sibley, and Higginsville were formed under prairie vegetation and have thick, dark surface layers, with silty clay loam subsoils. Floodplains are relatively narrow and inextensive, with very deep silty and clayey soils such as Colo and Zook.

HYDROLOGY

The subsection contains parts of the drainage basins of the Nodaway, One Hundred and Two, and Platte Rivers, and numerous smaller, perennial streams draining directly to the Missouri River. Gradients of smaller streams in the Missouri River breaks are moderately steep. Gradients of the larger streams are naturally low due to their intensely meandering courses. Valleys are often wide in relation to stream size,

Tim Nigh

Upland prairie landscapes give way to timbered hill and breaks near the rivers in the Loess Hills subsection.

although wide valleys in till can be abruptly narrowed where a stream cuts through resistant sedimentary rock. Many streams have been straightened and their gradients steepened. The abandoned meandering channels remain in the landscape as wetlands. Channels are mostly in silt, except where they cross bedrock outcrops in river breaks. Streams carry high suspended loads of silt and clay, especially during times of high runoff. Average streamflow is greatest in spring and early summer and drops off rapidly during summer. Many streams are subject to "going dry" or nearly so during protracted summer dry periods. Floods are common in this region of high rates of runoff and few flood-protection structures. Springs are not common. The subsection had no natural lakes, but many bottoms were formerly seasonally wet before being drained for agriculture. Numerous ponds and lakes have been constructed for livestock watering, municipal supplies, and residential developments in urbanizing areas. Water quality is compromised by agricultural runoff, including livestock operations, and by urbanization in the Kansas City and St. Joseph areas. Groundwater is relatively abundant from deep aquifers, but it is saline in most places.

TERRESTRIAL NATURAL COMMUNITIES

Historic. Prairies covered a high percentage of the subsection, blanketing most of the northwestern portion and the more gentle landscapes in the south. Oak savanna and woodland occupied steeper lands along valleys, and oak and mixed-hardwood forest densely covered the rugged breaks along the Missouri River. While most bottoms were timbered, lowland prairies and marshes were present, especially in the northwest.

Current. The region is dominated by farms with cropland occupying alluvial plains and the less dissected uplands, and nonnative, cool-season pasture occupying the more sloping lands. Pastures often have scattered, isolated savanna trees. Second-growth forest is confined to patches in the roughest land, especially in the breaks along the Missouri River. Remnant natural communities are rare, fragmented, and scattered.

Major Natural Community Types

Midwest Dry-Mesic Glaciated Prairie

Central Mesic Tallgrass Glaciated Prairie

Bur Oak Central Dry-Mesic Glaciated Savanna

Central White Oak Dry-Mesic Glaciated Woodland

Midwest White Oak–Red Oak Dry-Mesic Glaciated Forest

Central Maple-Basswood Mesic Glaciated Forest

Rare or Restricted Natural Communities. All natural communities on glacial materials are rare because of their wholesale conversion to agriculture. Most communities native to this ecoregion were widespread across northern Missouri. Some of the best remaining glacial forests are in the steep breaks along the Missouri River. Streams are suffering from siltation and agricultural pollution. Some marshes, saline springs, and fens occurred historically, but only a few quality remnants are known.

NATURAL DISTURBANCES

Fire, grazing, and drought would have helped create and maintain this grassland-dominated landscape.

RARE OR ENDANGERED SPECIES

The Loess Hills Subsection contains more than 150 records of 86 state-listed species. Most of the species are associated with upland prairie or wetland habitats. Three species of federal concern are the Indiana bat *(Myotis sodalis),* pallid sturgeon *(Scaphirhynchus albus),* and western prairie fringed orchid *(Platanthera praeclara).* Nine species, mainly from wetlands, have their only records of occurrence in Missouri within this subsection.

NATURAL AREAS

The Loess Hills Subsection has three designated Natural Areas: Maple Woods, Van Meter Forest, and Hidden Valley. All represent upland forest systems.

PUBLIC LANDS

The Loess Hills Subsection contains more than 35,000 acres, most (28,000 acres) of which are owned by the Missouri Department of Conservation. Prominent

Jim Rathert

Trees were thinly scattered or occurred in groves in the high, rolling prairie dominated landscapes of the Loess Hills Subsection.

Conservation Areas include Bilby Ranch, Bluffwoods, Maple Leaf Lake, Nodaway Valley, Perry Memorial, Platte Falls, and River Breaks. State parks include Weston Bend and Van Meter. Squaw Creek and Little Missouri Bend National Wildlife Refuges, managed by the U.S. Fish and Wildlife Service, touch the subsection. In addition, 3,000 acres at Smithville Lake, managed by the U.S. Army Corps of Engineers, are in this subsection.

HUMAN GEOGRAPHY

Demographics. This subsection was one of Missouri's major regions of Indian settlement. Especially in the Missouri River breaks between Kansas City and Saline County, many different Indian groups had settlements or camps at various times and collectively over a very long period of time. In Saline and neighboring counties, Great Osage, Little Osage, and Missouri Indians had major settlements, such as at Van Meter State Park, which preserves their legacy. Indians burned prairies, as at Fire Prairie in Jackson County. A variety of Indians lived or hunted in northwestern Missouri until it was added to the state. French who moved along the Missouri River before the turn of the nineteenth century also utilized these blufflands, more for trading posts (at Kansas City and St. Joseph) than for agricultural settlement. Americans also used the blufflands for trading posts (Fort Osage). The people who settled the subsection early on were old-stock Anglo-Americans and their slaves. After the Civil War the northern part of the subsection received a significant immigration of old-stock Anglo-Americans from states north of the Ohio River and from Europe. Cities have attracted a wide variety of immigrants from all parts of the United States and from the world.

Economics and Land Use. Permanent agricultural settlement came quickly in the nineteenth century. The eastern end of the subsection was occupied by farms shortly after the War of 1812. Agricultural settlement spread to the Kansas City area by the mid-1820s and into northwestern Missouri by the mid-1830s. The farms were commercial, with hemp and tobacco the chief cash crops. Corn, hay, and oats were also important, as well as a livestock industry of cattle, mules, and hogs. Farming was done with the help of slaves. By the Civil War, this was one of the foremost agricultural regions of Missouri, with one of the largest and densest rural populations. The Civil War caused great dislocations in the rural economy and in society in general. Hemp virtually disappeared and tobacco very nearly so. Some large farms disintegrated from lack of labor and fields were abandoned. The coming of railroads helped redevelopment of commercial agriculture, founded more on corn, hogs, cattle, and wheat. Soybeans were added in the twentieth century. Farm population has declined steadily since the beginning of the twentieth century, although production has increased tremendously. Marginal farmland has been taken out of cropland and put into pasture or woodland. In general, agriculture, both crops and livestock, is a very vigorous part of the economy of this subsection. Specialty crops include tobacco, chiefly in Platte and Buchanan Counties; apples in Lafayette and Saline Counties; and truck farms and dairying in the Kansas City metropolitan area. Farm population loss has been partially compensated by growth of towns and cities and rural nonfarm population. St. Joseph developed in the middle and late nineteenth century as a western trailhead and a market for livestock, wheat, and corn. It has continued as the major urban center of northwestern Missouri and has a significant industrial base. Kansas City got its start about the same time and for the same reasons. It has grown into Missouri's largest incorporated city in population and area and has an industrial, business, and service

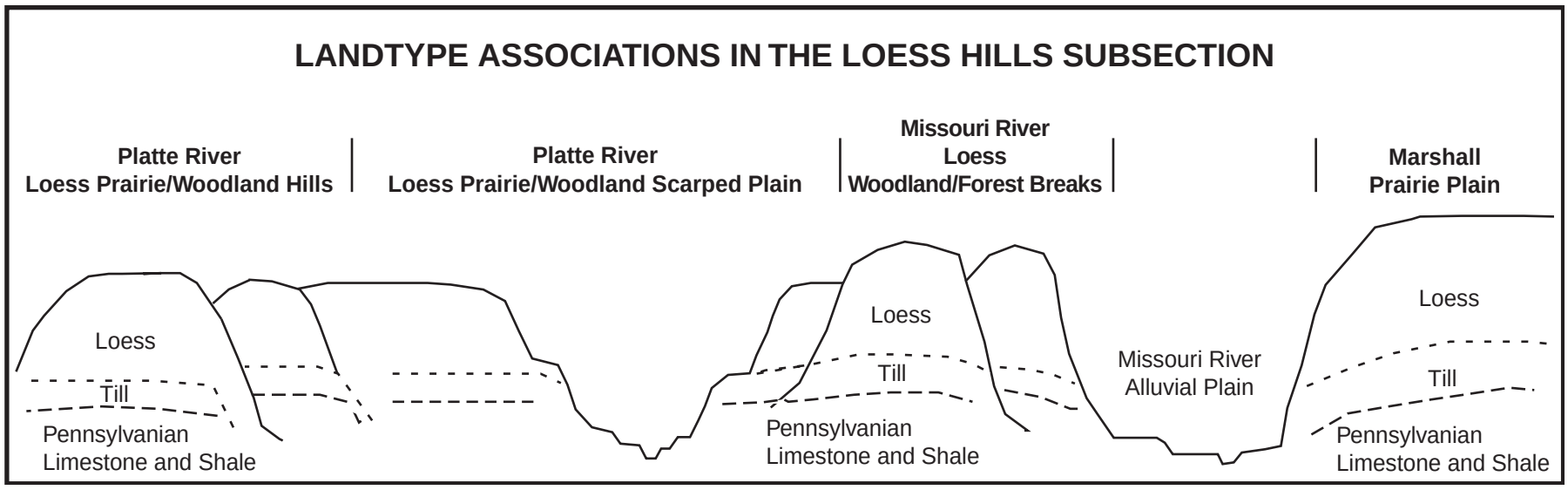
economy of national stature. Smaller towns like Marshall, Higginsville, Lexington, Carrollton, Richmond, and Maryville are agricultural and service centers for their respective regions.

LANDTYPE ASSOCIATIONS

The Loess Hills Subsection is subdivided into six landtype associations (LTAs). These include broad, flat alluvial plains, very steep river breaks, rolling hills historically dominated by prairie, more broken lands with historic prairie and woodland, and a flat prairie plain. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The loess soils are highly erodible in the absence of good farming practices. Excessive erosion not only degrades the long-term productivity of the land but also sends massive amounts of sediments into streams. Because of the virtually complete conversion of land to agriculture, very little natural vegetation remains. Only one typical glacial prairie remnant is known, and neither it nor any of the known wetland sites are in conservation ownership. Several outstanding forests are conserved in the River Breaks LTA. A regional effort to conserve glacial prairies and wetlands and to restore glacial prairie/woodland landscapes is needed.



(see landtype associations map pgs. 58–61)

LANDTYPE ASSOCIATIONS IN THE LOESS HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP3a Loess Hills Alluvial Plains	The LTA occupies broad alluvial plains on the Nodaway, One Hundred and Two, and Platte Rivers, mainly in Nodaway County. The LTA also includes a small area at the mouth of the Platte River in Platte County, a small area at the mouth of Fishing River in Clay County, a small area associated with the Little Blue River in Jackson County, and a small area along Davis Creek in Lafayette County. Boundaries encompass alluvial plains that are more than 1 mile wide.	These flat alluvial plains have little appreciable relief, except as associated with low terraces. Soils are mainly very deep and formed in alluvial materials of variable loamy, silty, and clayey textures. Considerable upland loess has been redeposited onto the alluvial plains. Both moderately drained and poorly drained hydric soils are common. Streams are very low gradient and naturally intensely meandering, although channelization in the first decades of the twentieth century has straightened most. Flooding is common, especially at the lower ends of channelized segments. The old, abandoned channel segments form wetlands. Historic vegetation was a mosaic of lowland prairie, marshes, and bottomland forest. Today these landscapes are more than 95 percent cropland.
TP3b Missouri River Loess Woodland/ Forest Breaks	The LTA occupies a disconnected series of twelve areas of rugged loess-covered hills bordering the Missouri River on both sides in Missouri from Mound City in Holt County downstream to Glasgow in central Missouri. The alluvial plains of the Missouri form one boundary of these units. The other boundary with upland LTAs marks the limit of rugged river breaks topography with narrow ridges, steep slopes, and local relief more than 200 feet.	The LTA consists of rugged, deep loess hills bordering the Missouri River valley. Local relief is generally above 200 feet. Narrow ridges, steep slopes, and numerous short, steep drainages characterize this landscape. Historically, the LTA was timbered in oak and mixed-hardwood woodland and forest. Today, the roughest lands are still timbered in second-growth forest, and the balance is mainly cool-season pasture with scattered croplands and apple orchards. Numerous parcels of public lands are in the LTA. Much of the LTA in the Kansas City and St. Joseph metropolitan areas is thoroughly urbanized.
TP3c Nodaway Loess Prairie Hills	The LTA occupies broadly rolling hills associated with the upper Nodaway, One Hundred and Two, and Platte Rivers mostly in Nodaway County. The western boundary marks the transition to thicker loess and leaving Sharpsburg soils. The eastern boundary is placed for convenience on the divide between the Platte River and Grand River basins and is also a transition to thinner loess. The southern boundary recognizes the transition to a more highly dissected landscape with a greater predominance of woodland soils and woodland potential vegetation.	The LTA consists of broadly rounded, loess-covered hills with moderately steep slopes, broad stream valleys, and local relief of 100–150 feet. Loess is generally 10–25 feet thick; glacial till is exposed on lower valley slopes. Historically, the LTA was covered in prairie with groves of timber confined to the deepest ravines and protected slopes and with belts of timber along major streams. Today, the productive but erodible soils are in a mix of cool-season pasture and cropland with very little native vegetation.

LANDTYPE ASSOCIATIONS IN THE LOESS HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP3d Platte River Loess Prairie/ Woodland Hills	The LTA occupies moderately dissected hills associated with the middle Platte River valley and the western side of the Bee Creek basin. The northern boundary is placed at the northern limit of the narrow ridges and valleys of this LTA, more till-derived soils, and less historic prairie. The western boundary is placed where relief increases above 200 feet in the Missouri River breaks. The eastern boundary marks the transition to a plains landscape with relief less than 100 feet. The southern boundary is placed where loess is more restricted in the landscape and where bedrock crops out on slopes.	The LTA consists of moderately broad to narrow, loess-covered ridges that give way to slopes cutting into glacial till. Local relief is 100–200 feet. Valley width varies considerably due to the influence of pre-Pleistocene buried stream valleys. Some of the major streams have been channelized but are subject to flooding. Historically, prairie dominated the ridges and stream divides, grading into oak savanna and woodland on lower slopes. Forest occupied deeper valleys and protected slopes. Today, the region is a nearly even mix of cropland on productive soils and cool-season pasture. St. Joseph and I-29 exert development pressures on the LTA.
TP3e Platte River Prairie/Woodland Scarped Plain	The LTA occupies broad upland plains and rather abrupt valleys associated with the lower Platte River and several short tributaries to the Missouri River in Platte and Clay Counties. The western and southern boundaries mark an increase in relief above 200 feet in the adjacent Missouri River Breaks LTA. The northeastern boundary is a transition to lower-relief till plains. The eastern boundary in Clay County marks a distinct change to a landscape that is more influenced by bedrock and less influenced by loess.	The LTA consists of broad upland ridges, formerly prairie, that give way abruptly to steep-sided hills and rather narrow valleys that were formerly oak savanna and woodland. Local relief ranges from 100 feet near the till plains to 150 and 200 feet along major streams. Much of this landscape has been thoroughly urbanized, except in its northern extent, in association with metropolitan Kansas City, major highways, and Kansas City International Airport. Smithville Lake is partially in the LTA.
TP3f Marshall Prairie Plain	The LTA occupies a broad, flat, loess-covered plain between the Missouri and Blackwater Rivers in Lafayette and Saline Counties. Boundaries are drawn to encompass an area of low relief (less than 75 feet) and loess-derived prairie soils.	The LTA consists of a flat to minimally dissected plain with a local relief less than 75 feet. Streams flow in broad, shallow valleys with very little bedrock exposed on slopes. Thin glacial till over Pennsylvanian shales underlies much of Saline County, but the till is patchy elsewhere. The LTA was nearly pure prairie before European settlement, with timber only along stream courses. Deep, productive loess soils and smooth topography now support cropland throughout the LTA. Several very unique glacial fen complexes occur.

TP4
GRAND RIVER HILLS SUBSECTION

(see map pgs. 62–63)

GENERAL DESCRIPTION

This large, compact subsection incorporates a variety of landscapes, but the integrating factor is a plains landscape and the presence of pre-Illinoisan glacial till with a thin cover of loess. In places, however, the till has been completely removed to expose Pennsylvanian sedimentaries. Stream erosion has dissected the surface into tracts of differing degrees of surface roughness and local relief. In places the uplands are relatively smooth, with relief less than 100 feet. Rolling hills tend to have 150 feet of local relief, while more dissected tracts can have relief over 200 feet. Presettlement vegetation was an intricate mosaic of prairie and timber, spatially associated with the pattern of ridges and valleys. Most of the subsection is devoted to farming, with row crops on the smoother uplands and broad valley bottoms and with pastures and woodlands on sloping lands.

LOCATION AND BOUNDARIES

The large subsection lies in the interior of northern Missouri. It comprises all of six counties (Gentry, Harrison, Daviess, Caldwell, Mercer, and Grundy), most of six other counties (Worth, DeKalb, Clinton, Livingston, Ray, and Carroll), and small portions of eight other counties (Nodaway, Andrew, Buchanan, Clay, Putnam, Sullivan, Linn, and Chariton). The northern boundary is the Iowa state line. The western boundary is conceptually placed where soils on till, which dominate this subsection, change to loess soils of the Loess Hills Subsection. Because the line has to be generalized, the drainage divide between the Grand and Platte Rivers is used for convenience for the boundary in Worth and Nodaway Counties. The boundary on the south is also based on the difference between soils on till and soils on deep loess along the Missouri River. The wide alluvial plain of the Grand River projects a deep salient into the Grand River Hills Subsection. The eastern boundary with the Chariton River Hills Subsection is drawn to approximate a general change from prairie-dominated landscapes with mollisols of the Grand River Hills, to more rugged, woodland-dominated landscapes with alfisols of the Chariton River Hills. This subsection continues north into a large area of southern Iowa.

CLIMATE

Mean annual precipitation is 35–39 inches. The wettest months are May–September, and 68 percent of the annual precipitation occurs during the six warmer months of the year (at Trenton). The wettest month, May, averages over five times as much precipitation as the driest month, February. Annual snowfall ranges from 24 inches in the north to 20 inches in the south. Mean January minimum daily temperature ranges from 12° in the north to 16° in the south. Mean July maximum daily temperature is 88–89°. The growing season averages 200–205 days. Microclimatic variations are weakly developed in this subsection of moderate relief.

TOPOGRAPHY AND GEOLOGY

The subsection is underlain by alternating (cyclical) beds of shales, thin limestones, coals, and a few sandstones of Pennsylvanian age that dip very gently northwestward into the Forest City structural basin in northwestern Missouri. These bedrock formations are exposed along some major stream courses where streams have cut through the overlying glacial till and loess. Limestone shoals occur in several places in stream channels. Bedrock also occurs in tracts where the glacial till was thin and has been removed or was nonexistent. These include much of Ray County, northwestern Carroll County, central Caldwell County, eastern DeKalb County, northwestern Livingston and southwestern Grundy Counties, and eastern Putnam County. These tracts where there is no till are decidedly hilly (relief of 100–200 feet), with rock outcrops and thin residuum. Throughout the greater part of the subsection, however, the landscape is formed on pre-Illinoisan glacial till, which varies from a few feet to over 300 feet in thickness (thicker in northern and western portions), which is in turn overlain by a thin veneer of late Pleistocene and Holocene loess (usually much less than 10 feet deep). Most of the landscape is a gently rolling plain with a relief of 80–150 feet, with valleys cut shallowly into the till and loess. Slopes are gentle to moderately steep. Valley bottoms tend to be quite broad for the small size of the streams and are naturally poorly drained. Ridge crests are broad, smooth, and rounded. In places stream dissection has hardly affected the till-loess surface and smooth uplands (with less than 100 feet of relief) remain. Such smooth plains are on the interfluves between the Grand and Platte Rivers on the western side of the subsection and on the divide between the Grand and Thompson Rivers in Harrison and Daviess Counties. Limestone is quarried in a few places where it is exposed. Historic coal mines (shaft and adit) occur in Ray and other counties.

Jim Rathert

The endangered western prairie fringed orchid is known only from several mesic glacial prairies in northwestern Missouri.

SOILS

Soils vary considerably within the subsection. Most of this variability is due to differences in the vegetation under which the soils formed, the parent materials in which the soils formed, and position on the landscape. Soils in most of the area were formed under prairie vegetation and consequently have thick, dark surface layers. Soils that formed under transitional or savanna vegetation generally have thinner surface layers and are also extensive in the area, particularly on lower slopes. Soils that formed under timber have thin surface layers and are relatively uncommon within the subsection. Most upland soils in the subsection were formed in loess of variable thickness over glacial till. Loess has a very low sand content, so soils formed in loess within this subsection generally have silt loam surface layers with silty clay loam or silty clay subsoils. Glacial till has a higher sand content, so that soils formed in glacial till generally have clay loam or clay subsoils. Loess is generally thickest on the interfluves and thins downslope, so that in a typical hillslope sequence in this subsection, the interfluve soils were formed entirely in deep loess; the shoulder-, head-, and upper backslope soils were formed in thin loess over glacial till; and the steeper, lower backslope soils were formed in glacial till with perhaps a very thin layer of surface material that has moved down the slope (pedisediment). In a few areas, particularly in the southeastern portion of the subsection, upland soils have formed in the underlying Pennsylvanian-age shales and limestones. This material is generally clayey and may contain fragments of the underlying bedrock.

The broad, gently sloping interfluves are dominated by prairie soils formed in loess, such as the Grundy series. Prairie soils such as Lagonda are on narrower ridges and were formed in loess over pedisediment and glacial till. In the prairie, glacial till soils are dominant lower on the hillslope, with Lamoni soils in headslopes and upper sideslopes, and Shelby soils on lower backslopes. In areas where the backslopes formed under savanna vegetation, glacial till soils such as Armstrong and Gara are common. Most of these upland soils have seasonally perched water tables within the clayey subsoils, which dry out in summer.

Alluvial-plain soils were formed in deep alluvium derived from a mixture of loess and glacial till. Soil texture and drainage vary widely and are mostly related to position within the alluvial plain. Typically, soils nearest the stream channel have coarser textures and are well or moderately well drained, such as the silty Nodaway soil series. Soils in back swamp or slack water positions are generally clayey and poorly drained, such as the Zook series. Broad transitional areas are intermediate in texture and drainage. The Colo series is typical in these areas.

HYDROLOGY

The large subsection extends over many drainage basins. It includes virtually all of the Grand River basin within Missouri, including the tributaries of Big River, Thompson River, Weldon Fork, Medicine Creek, and Shoal Creek. The subsection

also includes tributaries to the Platte River on its southwest, and rather short tributaries to the Missouri River on the south, including portions of Fishing, Crooked, and Wakenda Creeks. In general, stream channels are silty and the streams carry high suspended loads, especially in streams closer to the Missouri River. Where streams have cut through the glacial tills to underlying sedimentaries, channels are on bedrock and create shoals. The silty channels naturally have low gradients and have extremely meandering courses with reasonably stable banks. However, many long stretches have been straightened by channelization, and this action has thrown those streams out of equilibrium and into a degrading mode. Banks are no longer stable and channel depth has increased. At the end of a channelized stretch, the frequency of flooding has increased and thick layers of silt have been deposited, resulting in valley aggradation and chronic wetness. In some places readjustment to a new equilibrium may be close to being achieved. In general, streamflow in the subsection is highest from March to June and then declines very rapidly during summer to a minimum flow from August to January. The average discharge in August of the Grand River near Sumner is only one-fifth of its average discharge in June. Flooding from high-intensity rains or continuing rains occurs frequently and causes bottoms to be wet for long periods of time. There are very few flood-control works for such a large drainage basin. Conversely, protracted dry spells in summer may cause smaller streams to dwindle to very low flows or none at all, leaving only pools. The only natural lakes and wetlands were those in the broad alluvial bottoms. Most have been drained in association with stream channelization. A few remain, such as at Pershing State Park. Smithville Lake on the Little Platte River has been constructed for multiple purposes, including flood protection. Tens of thousands of ponds and small lakes serve for stock watering or irrigation supplies. Other lakes serve as municipal water supplies and provide recreation. A few small springs in the area are mostly saline. Surface water may often be of poor quality, especially during low-flow periods, due to agricultural land use and some very large hog and cattle operations. High turbidity is also common during periods of runoff. Runoff from historic coal mines is a risk to water quality locally. Groundwater from bedrock is saline or brackish and is generally unusable for domestic, irrigation, or stock-watering purposes. This condition prompts the development of lakes for water supplies. In favored places buried, pre-Pleistocene valleys in the Pennsylvanian bedrock are filled with glacial sands and provide large supplies of fresh groundwater.

TERRESTRIAL NATURAL COMMUNITIES

Historic. Most of the upland surface of the region was formerly tallgrass prairie. Prairie graded into oak savannas and woodlands on steeper lands, especially on the eastern sides of the larger stream valleys, likely the fire shadows of the streams. Bottomlands were a mixture of lowland or wet prairie, marshes, and bottomland woodland and forest.

Current. The region is dominated by farms with cropland occupying alluvial plains and flat uplands and nonnative, cool-season pasture (fescue or brome) on the more sloping lands. Pastures often have old, single-standing savanna trees scattered throughout. True savannas and open woodlands are virtually absent. Invasive timber has also grown up along fencelines and in abandoned farm ground. Second-growth oak and mixed-hardwood woodland or forest are confined to patches in the roughest land. Remnant natural communities are rare, fragmented, and scattered.

Major Natural Community Types

Midwest Dry-Mesic Glaciated Prairie

Central Mesic Tallgrass Glaciated Prairie

Central Bur Oak Glaciated Dry-Mesic Savanna

Central White Oak Dry-Mesic Glaciated Woodland

Midwest White Oak–Red Oak Dry-Mesic Glaciated Forest

Bur Oak, Swamp White Oak, Shellbark Hickory Mesic Bottomland Woodland

Rare or Restricted Natural Communities. All natural communities on glacial materials are rare and scattered because of the almost complete conversion to agriculture. Most communities native to this ecoregion were widespread across northern Missouri. Unusual bottomland woodlands of bur oak, swamp white oak, and shellbark hickory were common, but are rare today. Streams suffer from siltation and agricultural pollution. Marshes occurred historically, but only a few quality remnants are known. While numerous small prairie remnants are known, they are mostly small and isolated. Efforts are underway to restore a large glacial prairie landscape at Dunn Ranch in Harrison County.

Paul Childress

Much of the Grand River and its tributaries has been leveed and/or channelized to allow agricultural utilization of the rich alluvial soils.

NATURAL DISTURBANCES

Fire and grazing would have created and maintained the prairies, savannas, and open woodlands of the region, with the complex mosaic being related to topographic influences and fire. Flooding would have influenced the diversity of communities in the bottomlands.

RARE OR ENDANGERED SPECIES

The Grand River Hills Subsection contains almost 200 records of 60 state-listed species, which is a low number relative to the size of the subsection. Most of the species are associated with upland prairie or wetland habitats, and many of these are confined to glaciated northern Missouri. Five species of federal concern are known: Indiana bat *(Myotis sodalis),* Topeka shiner *(Notropis topeka),* bald eagle *(Heliaeetus leucocephalus),* Mead's milkweed *(Asclepias meadii),* and western prairie fringed orchid *(Platanthera praeclara).* Three species have their only records of occurrence in Missouri within this subsection: prairie mound ant *(Formica montana),* another ant *(Formica fossaceps),* and Virginia rail *(Rallus limicola).*

NATURAL AREAS

There are five designated Natural Areas in the Grand River Hills Subsection. Helton Prairie is the only glacial prairie represented in an immense region once dominated by this community. Bagley Woods and Isley Park Woods represent the region's forests. Chloe Lowery Marsh has an excellent marsh and wet meadow. Locust Creek is an outstanding bottomland prairie/woodland complex.

PUBLIC LANDS

The Grand River Hills Subsection contains more than 55,000 acres of public land. The Missouri Department of Conservation owns a majority of these lands (more than 35,000 acres), including Bunch Hollow, Crooked River, Elam Bend, a portion of Fountain Grove, Gallatin, Helton Memorial, King Lake, Pawnee Prairie, Poosey, and Seat Conservation Areas. There are more than 7,000 acres in four state parks: Pershing, Wallace, Crowder, and Watkins Mill. The U.S. Army Corps of Engineers manages 15,000 acres at Smithville Lake. A small portion of Swan Lake National Wildlife Refuge touches the region.

HUMAN GEOGRAPHY

Demographics. The subsection was occupied by various Indian groups into the early nineteenth century. It served as a primary hunting region for Sauk, Fox, and Pottawatomi, but there were also settlements and villages along many of the larger streams. Utilizing Indian routes and sites, Americans entered the subsection as hunters and trappers in the early nineteenth century. Burning the grasslands aided hunting. Permanent settlement began in the 1820s in the southern edges along the Missouri River and progressed northward during the 1830s and 1840s, generally staying in valleys of perennial streams but using the extensive prairies for open-range livestock grazing. The people who settled the subsection before the Civil War largely came from states south of the Ohio River. Later settlers came chiefly from states north of the Ohio River and included European immigrants, mostly German. The population kept increasing until the turn of the twentieth century, at which time the rural population began a decline that has continued unremittingly into the twenty-first century. In a few counties, growth of towns offsets the loss of rural

population, but in most counties the total population is less than one-half, sometimes as little as two-fifths of the county population of 1900. Such severe population losses have put a continuing strain on local services (health, educational, and religious) and local economies.

Economics and Land Use. Early farming was mostly subsistence, except in the better settled southern parts. After the Civil War when railroads were built in the region and wire fencing became available, further immigration took place and these new settlers laid out farms on the ridges and broader prairie uplands. Agriculture became more commercial. Corn and livestock were emphasized. The southern counties became one of the nation's major mule-breeding regions. As the twentieth century progressed, major adjustments took place in the farm economy. Farm sizes grew. Farms on marginal lands were abandoned, and crops were taken off poorer and eroded soils; these lands became pasture and woodland. The agricultural economy now emphasizes corn and livestock, both cattle and hogs, and soybeans and wheat in some districts. Tobacco is grown locally in the southern parts. Some very large hog operations have begun operation at the end of the twentieth century in Mercer and other counties. Commercial activity and services are largely restricted to the few small towns of the region, including Chillicothe, Trenton, Brookfield, and Cameron; Richmond and Carrollton are on the southern margin. There is little manufacturing and limited recreation and tourism in this large subsection. Coal mining is no longer present. Land use is overwhelmingly agricultural. Most of the farmland is in pasture, both improved and wooded, and a minor fraction is in crops. This division however, varies around the subsection. In counties with better soils and less relief, like DeKalb and Linn, crops retain great importance. In other counties that are hillier, like Worth, Harrison, and Mercer, cropland is much less important. Timber and woodlands occupy moderate to steep slopes and some narrow, eroded ridgetops. Most bottomlands are in row crops. Some tracts remain scarified from historic coal mining.

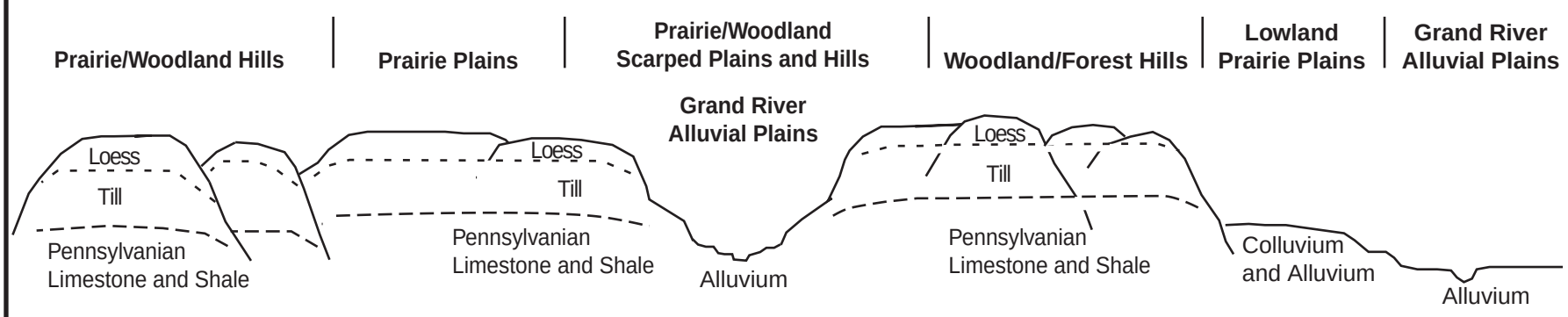
LANDTYPE ASSOCIATIONS

The Grand River Hills Subsection has been divided into eleven landtype associations (LTAs). The LTAs include broad, flat alluvial plains, flat upland or lowland prairie plains, and rolling landscapes that vary in their roughness, relief, and corresponding soil and vegetation patterns. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

Because of the high degree of agricultural conversion, very little natural vegetation remains. Only about 15 typical glacial prairie remnants are even known, and only a few of these are in conservation ownership. Several outstanding forests have been conserved, but no savannas or woodlands that were once so widespread are known. A major effort on a regional scale is needed to conserve glacial prairies and wetlands and to restore glacial prairie/woodland landscapes. A good example of such an initiative is at the Pawnee Prairie–Dunn Ranch Focus Area in Harrison County.

LANDTYPE ASSOCIATIONS IN THE GRAND RIVER HILLS SUBSECTION



(see landtype associations map pgs. 62–64)

LANDTYPE ASSOCIATIONS IN THE GRAND RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP4a Grand River Alluvial Plains	The LTA occupies disconnected parts of the alluvial plain of the Grand River and its major tributaries where the plain is more than 1 mile wide, excluding the lower Grand River below Locust Creek.	The LTA consists of a flat alluvial plain, mainly 3–5 miles wide, in which the Grand River and its tributaries meander in tight bends wherever they have not been straightened by channelization. Channelization has increased the gradient of streams, throwing many of them out of equilibrium. Flooding occurs frequently. Scattered oxbow lakes and old channels left from channel straightening form wetlands. Soils are very deep, formed in silty and clayey alluvium, and are generally moderately well drained except at the lower ends of channelized stretches, where chronic wetness occurs. Historically, the LTA was a mosaic of marshes, wet prairie, and bottomland forest. Today, it is in row crops with narrow bands of bottomland timber and occasional wetlands.
TP4b Upper Grand River Prairie/ Woodland Hills	The LTA occupies the hills of the Grand River Basin above the Gallatin Narrows near Old Pattonsburg. It covers much of Worth, Harrison, and Gentry Counties and includes a disconnected tract in the Thompson River valley in eastern Harrison County. The northwestern boundary is drawn on the drainage divide with the Platte River basin. The southwestern boundary is drawn where relief decreases to less than 100 feet, which is also a change to till-dominated soils. The eastern boundary also marks a change to relief of less than 100 feet on both the Gilman City upland and the Thompson River valley.	The LTA consists of a region of continuously rolling, closely spaced ridges and valleys carved from till, with little flat land except for an occasional broad bottom. Local relief is mainly 100–150 feet. Uplands have a loess cover, but much has been removed by natural erosion or accelerated erosion from farming. Historically, the LTA was upland tallgrass prairie on divides that graded into oak savannas and woodlands in more dissected land. Bottoms were a mosaic of bottomland forest, bottomland prairie, and wetlands. Today, the LTA has row crops in bottoms and mostly pasture on rolling uplands and slopes. Forests are rare and consist mainly of invasive elm, hackberry, and similar species. Wetlands are also rare. The LTA is overwhelmingly rural and agricultural with residential and commercial development scattered in small towns and along I-29.

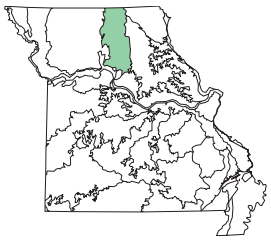
LANDTYPE ASSOCIATIONS IN THE GRAND RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP4c Cameron Upland Prairie Plain	The highly irregularly shaped LTA occupies the upland plains centered on DeKalb and Clinton Counties. The western boundary marks the beginning of loess-dominated surfaces. The crenulated eastern and southern boundaries, drawn at 100 feet of relief, mark the outer limit of the upland plains.	The LTA consists of a high plain, flat to very gently rolling, with smooth, rounded uplands and shallow stream valleys. Local relief is less than 100 feet and in many places less than 50 feet; slopes are 2–10 percent. Historically, the LTA was in extensive tallgrass prairies (80 percent of the LTA), with the rest in oak savannas and woodlands. Today, the uplands are a mix of row crops and cool-season pastures; bottoms are in cropland. Natural prairie is nearly absent, despite its former dominance. Invasive forests, mainly of elm and hackberry, occupy 11 percent of the LTA.
TP4d Little Platte River Woodland/ Forest Scarped Hills	The small LTA occupies the hills associated with Little Platte River and Castille Creek mainly in southwestern Clinton County. The eastern boundary marks the decrease to less than 100 feet of local relief. The western boundary marks the change to loess-dominated soils. The southwestern boundary marks where glacial materials become rare.	The LTA consists of broad, loess-covered, rounded ridges that give way sharply, as scarped hills, to moderately sloping valleys cut into till. Relief is 100–150 feet. Historically, the LTA was prairie on ridges and graded into oak woodland on scarped slopes and forest in valleys. Today, the LTA is mainly pasture with cropland on flatter uplands and bottoms. Smithville Lake occupies a substantial portion of landscape and invites recreational development from the Kansas City metropolitan area.
TP4e Crooked River Woodland/Forest Scarped Hills	The LTA occupies hills associated with Fishing and Crooked Rivers mostly in Clay and Ray Counties. The northern boundary marks a decrease in local relief to less than 100 feet. The southern boundary marks an increase in local relief to the more thoroughly dissected river breaks. The western and eastern boundaries mark changes into areas with much more glacial-till influence.	The LTA occupies an area made distinct by the absence or near absence of glacial till. Uplands are moderately broad to gently rolling, but the landscape is dissected by angular, stepped valley sides created by thin outcroppings of Pennsylvanian limestones and shales. Soils are developed in residuum from the sedimentaries. Historically, prairie was confined to narrow uplands, and much more of the LTA was a woodland/ forest mosaic with limestone glades than adjacent LTAs. Today, it is mainly pastures on uplands and gentle slopes with mostly woodland/forest in the narrow valleys and steep slopes.
TP4f Shoal Creek Prairie/Woodland Scarped Plain	The LTA occupies a large area of slightly dissected plains mostly south of the lower Grand River and mostly in Daviess, Caldwell, Carroll, and southern Livingston Counties. The extreme northwestern boundary marks the end of scarped topography. The irregular western boundary and the extreme northwestern boundary marks a change to even lower relief (less than 100 feet). The boundary on the southwest marks the end of rather continuous glacial till. The southern boundary begins the river hills that are deeply covered with loess. The southeastern boundary is a transition to lower relief at a lower elevation. The northeastern boundary is with the flat Grand River alluvial plain.	The distinguishing feature of the LTA is the low but sharp breaks in relief on the plains and in the shallow valleys that create a series of plateaulike surfaces. These breaks are caused by resistant Pennsylvanian limestone strata that either outcrop as rock ledges on valley sides (and road cuts) or are only slightly covered with residuum or glacial till. Local relief is low, less than 50 feet, over much of the uplands. Elsewhere relief rises to 150 feet in valleys and even to 200 feet in more scarped areas, such as northwestern Carroll County, where a collection of flat-topped, limestone-capped hills stand very conspicuously in the landscape. Many stream channels are on limestone bedrock; Shoal Creek is especially noteworthy. Historically, the LTA was prairie on the broad, flat uplands, with oak woodland and forest (especially limestone forest) in scarped valleys and some wetlands and bottomland forest in the wider valleys. Today, the LTA is mainly cool-season pasture with row crops in bottoms and on flatter uplands. Upland oak (limestone) forests and bottomland forests are associated with valleys. Wetlands are rare.
TP4g Gilman City Upland Prairie Plain	The LTA occupies a long, narrow, flat drainage divide west of the Thompson River, across Daviess and Harrison Counties, from Jamesport to the Iowa state line. Its boundaries everywhere are drawn to encompass land with local relief less than 100 feet.	The LTA consists of a flat to very gently rolling upland with local relief mainly less than 50 feet but rising to 100 feet on the margins. Slopes are very gentle, less than 8 percent. Upland soils are very deep, moderately well to somewhat poorly drained loams and clay loams formed in loess and glacial till. Historically, the LTA was almost completely upland prairie, with oak savanna in draws. Today, the LTA is mainly in cropland and pasture but includes some forest of invasive elm, hackberry, and associated species.
TP4h Trenton Woodland/Forest Scarped Hills	The LTA occupies the upland hills between the Grand and Thompson Rivers above their junction northwest of Chillicothe and west of Trenton. The southern and eastern boundaries are with the alluvial plains of those two rivers. Other boundaries are drawn to encompass the rugged, scarped hills of this LTA.	The LTA consists of relatively well-dissected hills with local relief of 100–200 feet. Upland ridges are moderately broad and underlain by till, but sideslopes are steep with numerous shelves and breaks caused by Pennsylvanian resistant limestones and nonresistant shales. Historically, the upland ridges were in tallgrass prairie and the abrupt, scarped valleys were oak woodlands and limestone forests. Today, the uplands are mainly in pasture and the valleys are in second-growth forest. Crowder State Park and other public lands are in this LTA.

(table continued on pg. 38)

LANDTYPE ASSOCIATIONS IN THE GRAND RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP4i Weldon River Woodland/Forest Hills	The LTA occupies thoroughly dissected hills around the Weldon Fork in Mercer and northern Grundy Counties. The western and southern boundaries are the alluvial plains of the Thompson River. The eastern boundary is drawn for convenience along Muddy Creek to mark the transition to somewhat less dissected land. The northern boundary is the Iowa state line.	The LTA consists of hills with narrow upland ridges, steep sideslopes, and narrow to moderately broad valleys, all constructed on glacial till. Bedrock is not exposed. Local relief is 150–200 feet. This is one of the more rugged tracts of glaciated topography in northern Missouri. Historically, upland ridges were in narrow strips of prairie that graded into oak woodlands on upper valley slopes and into forest on wetter, lower slopes. Today, the LTA is mainly pastured uplands with substantial forest in more rugged valleys. Large-scale livestock-feeding operations are located near Princeton.
TP4j Medicine Creek Prairie/ Woodland Hills	The LTA is located on both sides of Medicine Creek in eastern Mercer and Grundy Counties and western Putnam and Sullivan Counties. The western boundary is placed for convenience along Muddy Creek to mark increasing relief to the west. The eastern boundary also marks increasing relief into timbered hills. The southern boundary marks a decrease in relief to less than 100 feet. The northern boundary is the Iowa state line.	The LTA consists mainly of a series of parallel, north-south ridges and valleys, with gently rolling uplands, moderately sloping sideslopes, and moderately narrow bottomlands. Local relief is 100–150 feet, which is noticeably less than the hills to the west and east. This LTA also had more land in prairie than those adjoining hills. Historically, the LTA had extensive, tallgrass upland prairies that graded into oak savannas and woodlands on lower sideslopes and bottoms. Today, it is mainly pastured uplands and some cropped bottoms. Forests are scattered and consist mainly of invasive elm, hackberry, and associated species. Wetlands are rare. This agricultural LTA has very little public land.
TP4k Lower Grand River Lowland Prairie Plains	The LTA occupies five separate lobes of low relief flanking the lower Grand River alluvial plain and its tributaries. Boundaries are drawn to exclude alluvial plains but otherwise encompass land with less than 100 feet of local relief and gentle slopes less than 5 percent.	The LTA consists of five separate tracts of very gently rolling surfaces, only slightly above the adjacent alluvial plains. Relief is less than 100 feet, more commonly less than 50 feet, and slopes are remarkably low. It is difficult to determine precisely where the slopes merge by colluvium into the alluvium of the river plains. The surface is underlain by thin till with a slight loess covering; bedrock is not exposed anywhere. Soils are deep but poorly drained. Historically, the LTA was primarily upland and bottomland prairie. Oak savannas and woodlands graded to forests only in the lowest, most protected areas. Bottomlands were in marshes, savanna, and shrub swamps. Today, because of its very gentle relief, most of the LTA has been converted to cropland with scattered pastures and woodlots of invasive species. Bottom-lands have scattered shrub swamps and marshes with narrow belts of timber along streams. Flooding occurs frequently. Increasing development is occurring along US 36 between Chillicothe and Brookfield.

TP5
CHARITON RIVER HILLS SUBSECTION

(see map pgs. 64–65)

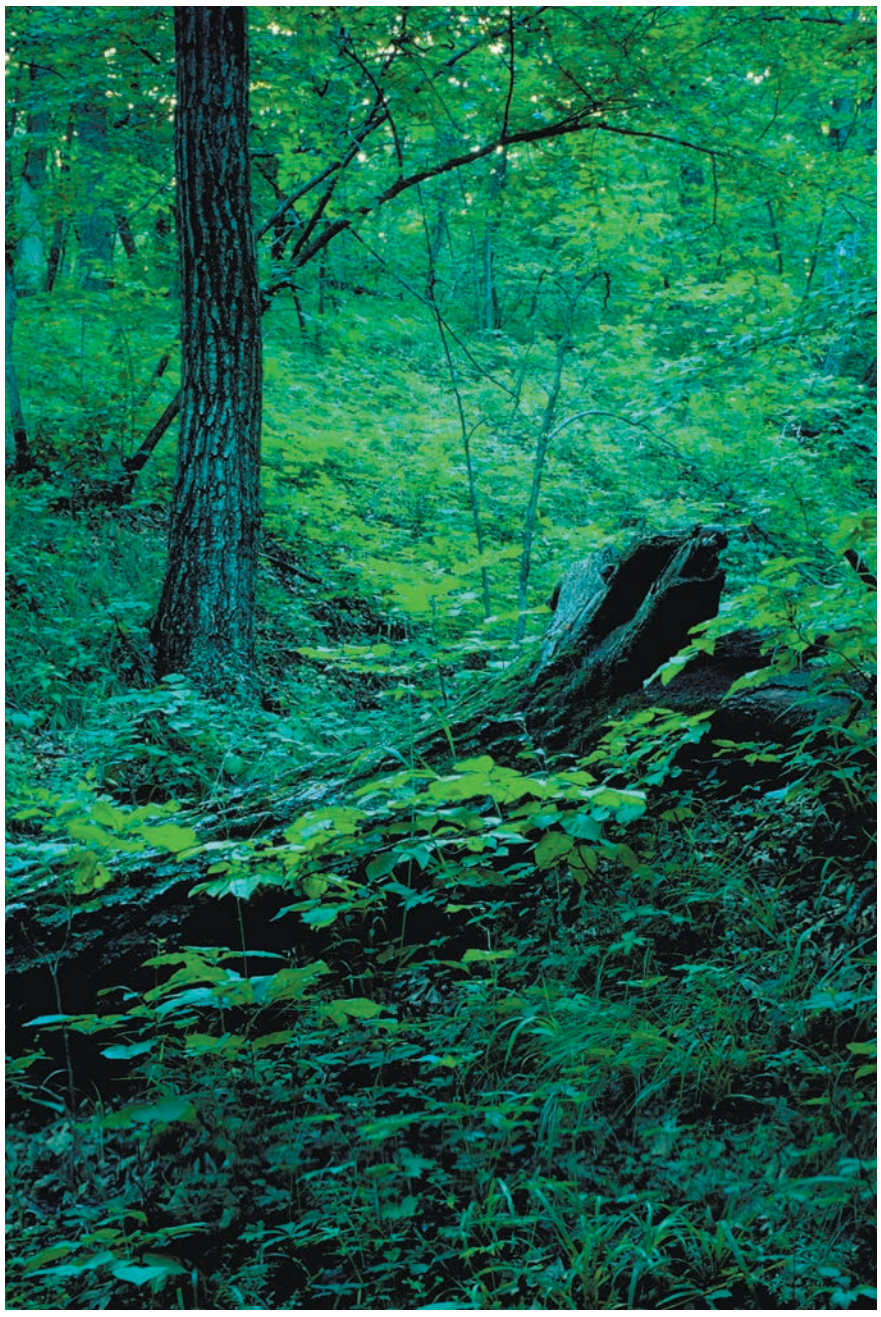


GENERAL DESCRIPTION

The Chariton River Hills Subsection contains the hilliest lands of interior northern Missouri. The subsection is constructed mainly on glacial till with a thin covering of loess, but in major areas these materials have been removed, exposing Pennsylvanian limestones, shales, and coals. Three types of landscapes are recognized: broad alluvial plains, thoroughly dissected and forested hills, and an intermediate landscape of gentler slopes and deeper soils. Presettlement vegetation was a mosaic of upland and wet prairies, savannas, and timbered slopes. Most of the subsection is now devoted to farming, with more cropland in the south and more pastureland in the north.

LOCATION AND BOUNDARIES

The subsection lies in interior northern Missouri. It comprises major portions of Putnam, Schuyler, Sullivan, Adair, Linn, Macon, Chariton, and Randolph Counties and a tiny portion of Howard County. The northern boundary is the Iowa state line. The eastern boundary is the watershed divide (called the Grand Divide) between the Chariton River basin and the Salt and other river basins that lead to the Mississippi River, with a minor exception in the headwaters of the East Fork of the Chariton River near La Plata. The southern boundary is placed where deep loess affects the nature of soils and topography or at the Missouri River bluff line. The western boundary with the Grand River Hills is drawn to approximate a general change from more dissected, woodland-dominated landscapes with alfisols to prairie-dominated landscapes of less relief with mollisols. In places the boundary is arbitrarily drawn.



Jim Rathert

CLIMATE

Mean annual precipitation is 37–39 inches. The wettest months are May–September, and 67 percent of the annual precipitation occurs during the six warmer months of the year (at Kirksville). The wettest month, September, averages over four times as much precipitation as the driest month, February. Annual snowfall ranges from 24 inches in the north to 20 inches in the south. Mean January minimum daily temperature ranges from 13° in the north to 17° in the south. Mean July maximum daily temperature is 88–89°. The growing season averages 200–205 days. Microclimatic variations are weakly developed in this subsection of moderate relief.

TOPOGRAPHY AND GEOLOGY

The subsection is underlain by alternating beds of shales, thin limestones, coals, and a few sandstones of Pennsylvanian age. These formations are exposed along streams, especially in Adair and Putnam Counties in the north and Randolph County in the south, where streams have cut through the overlying glacial till and loess. In such places the rock-controlled slopes are decidedly steeper, residuum thin, and the relief greater. Local relief is as much as 250 feet in these areas but is generally 150 feet in till regions. Most of the landscape is a rolling, dissected plain, but thorough dissection in the upper Chariton valley produces hills with narrow ridges and valleys. The Chariton River has an exceptionally broad valley, averaging 2–4 miles wide. Coal was formerly mined in many counties. Very extensive strip coal mining continued until about 1990 in the three-county area around the Thomas Hill power plant, but this mined area has been reclaimed.

SOILS

Soils in this subsection are nearly all very deep. Most upland soils range from moderately well to somewhat poorly drained, with silt loam surface layers and clayey subsoils. Upland soils on interfluves, such as the Pershing and Adco series, have formed in loess and have silty clay subsoils. Soils on backslopes were formed in glacial till and have thin (Keswick, Lindley series) to moderately thick (Armstrong series) to thick (Gara series) surface layers, depending on whether the native vegetation was timber, savanna, or prairie. The glacial till soils have clay loam to clay subsoils. The Chariton River alluvial plain soils were formed in very deep alluvium of variable texture and drainage. Carlow soils are clayey and poorly drained, whereas Tice and Dockery soils are loamy and somewhat poorly drained.

HYDROLOGY

The subsection corresponds basically with the Chariton River basin in Missouri, with small additions of other basins on its margins. In general, stream channels are silty, and streams carry high suspended loads and small bed loads. Where streams have cut into the sedimentaries, channels may be on limestone or shale. The silty channels naturally have low gradients and have extremely meandering courses with reasonably stable banks. However, many long stretches have been straightened by channelization; the length of the Chariton channel may have shortened to as little as one-fourth its former length. Straightening has thrown streams out of equilibrium and into a degrading mode. Banks erode and channels deepen, creating turbid streams with considerable siltation. In general, streamflow in the subsection is highest from March to June and then declines very rapidly during summer to a minimum flow from August to January. High-intensity or prolonged rains may produce floods and cause bottoms to be wet for long periods of time. No flood-control works exist on the main Chariton, although Long Branch Lake helps to manage runoff on the East Fork of the Chariton, and Thomas Hill Lake (built for thermal electricity generation) helps to regulate runoff on the Middle Fork of the Chariton. Protracted dry periods in summer may cause smaller streams to dwindle to very low flows or none at all, leaving only pools. The only natural lakes and wetlands were those in broad alluvial bottoms, and most of these have been drained by organized drainage districts. Thousands of ponds and small lakes serve stock-watering purposes, irrigation supplies, or municipal water supplies. Surface water may be of poor quality, especially during low-flow periods, due to agricultural and abandoned mine runoff. Groundwater from bedrock is saline or brackish and generally unusable for domestic, irrigation, or stock-watering purposes.

Dark Hollow Natural Area in Sullivan County contains a remnant of the rich, mesic glacial forest once scattered in the deepest valleys and ravines of the Chariton River Hills.

TERRESTRIAL NATURAL COMMUNITIES

Historic. This subsection had one of the most complex mosaics of prairie, savanna, woodland, and forest in Missouri. Broad prairie drainage divides and ridges graded into oak savanna and woodland, then into mixed-oak forest on the roughest land. The most complex mosaics occurred in the hilliest landscapes. Bottoms were a mix of prairie, marsh, and bottomland forest.

Current. The region is predominantly in fescue and brome pasture. Cropland is common on larger alluvial plains and broader uplands. Second-growth timber occurs in substantial blocks in the roughest lands. Small patches of timber and fencerows are often invasive second-growth with elm, hackberry, and locust most common. Larger patches are mainly mixed oak. Renmants of all-natural communities are rare.

Major Natural Community Types

Midwest Dry-Mesic Glaciated Prairie

Central Mesic Tallgrass Glaciated Prairie

Central Bur Oak Glaciated Dry-Mesic Savanna

Central White Oak Dry-Mesic Glaciated Woodland

Midwest White Oak–Red Oak Dry-Mesic Glaciated Forest

Bur Oak, Swamp White Oak, Shellbark Hickory Mesic Bottomland Woodland and Wet-Mesic Bottomland Forest

Central Cordgrass Wet Prairie

Rare or Restricted Natural Communities. Natural communities on glacial materials are rare because of their conversion to agriculture. Most communities native to this ecoregion were generally widespread across northern Missouri. High-quality remnants of natural communities are rare and scattered. Distinctive bottomland woodlands of bur oak, swamp white oak, and shellbark hickory were common here. Streams suffer from siltation and agricultural pollution. Some marshes occurred historically, but only a few quality remnants are known. While numerous prairie remnants are known, they are mostly small and isolated. Upland savannas and woodlands have been cleared or have succeeded to closed forest in the absence of fire.

NATURAL DISTURBANCES

Drought and subsequent fire played key roles in the creation and maintenance of this prairie and woodland mosaic. Grazing by deer, elk, and bison, as well as wind and ice storms, also added to its character. Annual floods shaped the diversity of wetland communities.

RARE OR ENDANGERED SPECIES

The Chariton River Hills Subsection contains more than 130 records of 45 state-listed species. Most of the species are associated with upland prairie, woodland, or wetland habitats, many of which are confined to glaciated northern Missouri. Numerous rare species are associated with streams in the region. Three species of federal concern are known: Indiana bat *(Myotis sodalis),* Topeka shiner *(Notropis topeka),* and bald eagle *(Heliaeetus leucocephalus).* Four species have their only records of occurrence in Missouri within this subsection: greater St. John's–wort *(Hypericum majus),* long-bracted orchid *(Coeloglossum viride* var. *virescens),* Louisiana vetch *(Vicia leudoviciana),* and water smartweed *(Polygonum amphibium).*

NATURAL AREAS

The subsection has only two designated Natural Areas. Nehai Tonkayea Prairie protects a prairie and oak woodland complex. Dark Hollow represents an upland woodland and forest.

PUBLIC LANDS

The subsection contains more than 50,000 acres of public land. Seventeen thousand acres are in U.S. Army Corps of Engineers ownership at Long Branch and Thomas Hill Reservoirs. The Missouri Department of Conservation manages many of the Corps lands, as well as more than 28,000 acres of its own. Prominent Conservation Areas include Atlanta, Locust Creek, Long Branch, Mineral Hills, Mussel Fork, Rebel's Cove, Sugar Creek, and Union Ridge. Long Branch and Thousand Hills State Parks have over 4,500 acres.

Jim Rathert

Upland sandpipers have diminished in number with the loss of prairies in north Missouri.

HUMAN GEOGRAPHY

Demographics. Various Indian groups used the Chariton country as hunting territory into the first years of the nineteenth century. Their routes and sites were later utilized by American settlers, who began entering after 1820 in the southern parts and reached the northern parts a decade or two later. Early settlement was mainly semisubsistence farming, except in the southern part, where access to the Missouri River made commercial farming possible. Population increased by immigration and natural growth until the end of the century, at which time rural population began a decline that has continued to the present time. Growth of towns has not been able to compensate for the large rural population loss, and most counties have only a fraction of their populations of 1900. Average population densities in some counties fall below ten per square mile.

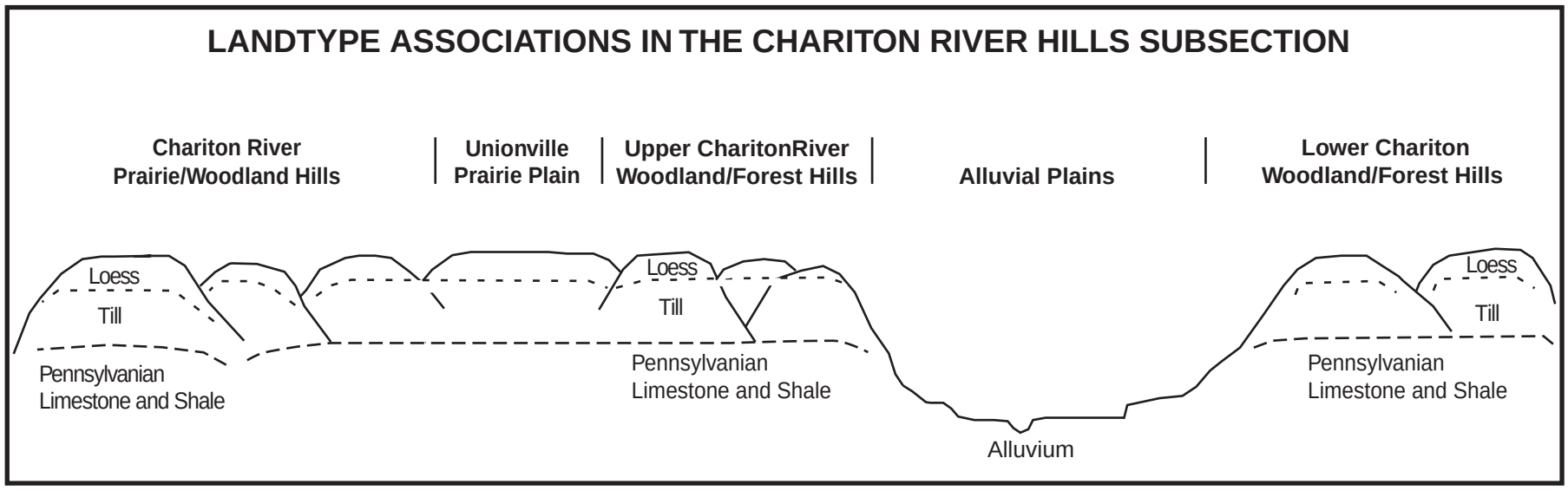
Economics and Land Use. Commercial agriculture became the mainstay of economics after the Civil War, when railroads opened the region. Railroads also made it possible to market the extensive coal resources. Major changes have taken place in agriculture during the twentieth century. Farm sizes grew, and marginal lands were taken out of crop production and turned into pastures. The agricultural economy is now firmly based in corn, soybeans, wheat, cattle, and hogs. All coal mining, whether shaft, adit, or strip, has now ceased in the Chariton River Hills. Commercial and industrial activities are small-scale and limited to small towns. Land use is overwhelmingly agricultural, mostly pasture with a minor fraction in crops. Cropland is concentrated in the alluvial valleys and gentler slopes and uplands in the central third of the subsection. Timber and woodlands dominate in the roughest lands of the upper Chariton valley and in Randolph County.

LANDTYPE ASSOCIATIONS

The Chariton River Hills Subsection is subdivided into landtype associations (LTAs). Six LTAs have been recognized, including alluvial plains and uplands that vary in their topography and corresponding soil and vegetation patterns. Some of these are typical rolling Prairie/Woodland Hills, others are flat Prairie Plains, and others are more rugged Woodland/Forest Hills. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

Because of the high degree of agricultural conversion, very little natural vegetation remains. Only five typical glacial prairie remnants are known and only a few are in conservation ownership. Several outstanding forests are conserved, but savannas and woodlands once so widespread are just now undergoing limited restoration. A regional-scale effort to conserve glacial prairies and wetlands and to restore glacial prairie/woodland landscapes is needed. Good examples are the efforts at the Union Ridge Conservation Area and Long Branch State Park.



(see landtype associations map pgs. 64–65)

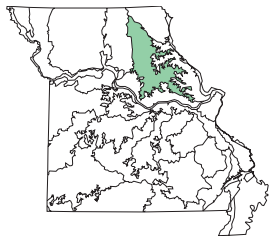
LANDTYPE ASSOCIATIONS IN THE CHARITON RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP5a Chariton River Alluvial Plains	The LTA occupies the Chariton River alluvial plain from the Missouri River bluff line to the Iowa state line. Also included are alluvial plains of the lower Middle and East Forks and the lower Mussel Fork. Boundaries are the bluff lines of these plains.	The LTA consists of a broad, flat alluvial plain 1–5 miles wide. The Chariton River was formerly intensely meandering but was straightened by channelization early in the twentieth century, leaving behind numerous segments of the old channel that now are timber-lined wetlands. Local relief is 10–20 feet. Soils are very deep, moderately well to poorly drained, formed in silty and clayey alluvium. Historically, the LTA was in bottomland prairie (approximately 25 percent), marshes, shrub swamps, savanna, and forest. Today, it is mainly in row crops, very narrow bands of wet and wet-mesic bottomland forest (less than 5 percent), and scattered shrub swamps and marshes.
TP5b Locust Creek Woodland/ Forest Hills	The LTA occupies dissected hills flanking Locust Creek in Sullivan and Putnam Counties. Boundaries are drawn to encompass a thoroughly dissected landscape with more than 150 feet of local relief and without extensive former prairies.	The LTA consists of a distinctly corrugated, north-south pattern of narrow, convex ridges, moderate to steep sideslopes, and narrow valleys. Local relief is 150–250 feet. It is one of the more thoroughly dissected landscapes of northern Missouri. Historically, narrow ridgetop prairies graded into woodlands and forested slopes. Although much of the land was farmed in row crops, today the LTA is mainly pastureland with forest on the steepest slopes and narrow valleys. Large-scale hog-raising operations are located in the LTA.
TP5c Unionville Upland Prairie Plain	The LTA occupies a long, narrow upland in Sullivan and Putnam Counties. Boundaries are drawn to enclose land with a local relief less than 100 feet. The northern boundary is the Iowa state line.	The LTA consists of a slightly dissected upland that has the headwaters of several streams. Local relief is generally less than 50 feet, with gentle slopes of less than 8 percent. Soils are very deep, moderately well drained, and formed in glacial till and loess over pedisediments. Historically, the LTA was an extensive upland prairie (75 percent) with oak woodland in headwater draws. Most of it was put into row crops at one time, but today it is mainly pasture, with minor amounts of row crop, and 9 percent forest of invasive species.
TP5d Upper Chariton River Woodland/Forest Hills	The LTA occupies the thoroughly dissected hills on both sides of the Chariton River generally north of US 36. Boundaries are defined by local relief above 150 feet. The northern boundary is the Iowa state line.	The LTA consists of the largest tract of rugged, dissected hills in northern interior Missouri. It consists of narrow ridges, steep sideslopes, and narrow valleys. Local relief is 150–250 feet. Soils are very deep, moderately well to well drained, and formed in glacial till and loess over pedisediments. Historically, the LTA was narrow ridgetop prairie that graded into woodlands, forested slopes, and valleys. Today, it is mainly pasture, with some of the largest blocks of second-growth timber in glaciated northern Missouri. Several large tracts in public ownership demonstrate community restoration using prescribed fire. Many abandoned coal mines and scarified surfaces are in the LTA.

(table continued on pg. 42)

LANDTYPE ASSOCIATIONS IN THE CHARITON RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP5e Chariton River Prairie/ Woodland Hills	The LTA occupies moderately dissected hills between the lower Chariton River and Locust Creek. Boundaries in the southern half are the Chariton River on the east, the Missouri River bluffs on the south, and a low-relief plain on the west. Boundaries in the northern half are drawn where local relief increases to more than 150 feet, except where relief smooths out in eastern Sullivan County.	The large LTA consists of a series of parallel hills and valleys that form a distinctly corrugated pattern. The land is moderately dissected with broad ridgetops, gentle to moderately steep sideslopes, and broad alluvial plains. Local relief is 100–150 feet. Slopes are generally 3 to 10 percent. Historically, the LTA was in extensive broad upland prairies (much more than in the hills to the east) that graded into woodlands on sideslopes, bottomland forest, and wetlands. Much of the LTA was in row crops in the first half of the twentieth century. Today, it is an even mixture of crop and pastureland. Forests (9 percent) are in limited areas of rough land and steep slopes and consist of upland oak and invasive species and, on the alluvial plains, wet and wet-mesic bottomland forest.
TP5f Lower Chariton Woodland/ Forest Hills	The LTA lies in the moderately dissected hills east of the Lower Chariton River in Macon, Randolph, and Chariton Counties. The eastern boundary is the Grand Divide (the drainage divide between the Chariton and Salt River systems). The western boundary is basically the Chariton valley. The southern boundary is drawn where loess and sedimentary bedrock become major influences.	The LTA consists of a moderately dissected landscape with broad divides that grade into smooth, gently sloping sideslopes that become steeper in the southern parts of the LTA. Valleys are moderately broad. Local relief is 100–200 feet. Soils are mainly alfisols formed under timber. Historically, the ridges had narrow prairies along them, but most of the LTA was in woodland, with forest on steeper slopes and narrow valleys. Today, it is a mix of row crop and pasture, with many tracts of second-growth timber on the roughest ground. Virtually the entire LTA south of US 36 experienced coal mining either by shaft and adit or, more recently, by large-scale strip mining. Much, but not all, of the coal-mined land has been reclaimed. Long Branch Lake and State Park and Thomas Hill Lake are included in the LTA.

TP6
CLAYPAN TILL PLAINS SUBSECTION

(see map pgs. 66–67)



GENERAL DESCRIPTION

The distinguishing feature of this subsection is the presence of well-developed claypan soils on a flat glacial till plain. Postglacial stream erosion has made little progress in this subsection, and most of the surface is flat or gently rolling with local relief less than 100 feet. Bedrock exposures are rare. Most of the subsection was formerly prairie, with narrow belts of timber along stream courses. Most of the subsection is now farmland, of which a very large percentage is in cropland.

LOCATION AND BOUNDARIES

The subsection lies in northeastern Missouri in the triangle between the Mississippi, Missouri, and Chariton Rivers. It comprises the major portions of Audrain, Monroe, Shelby, and Knox Counties, significant portions of Callaway, Boone, Randolph, Macon, Adair, Marion, Ralls, Pike, Montgomery, and Warren Counties, and very small portions of Schuyler, Lincoln, and St. Charles Counties. The southern boundary from St. Charles County to Randolph County is defined at a change in local relief to over 150 feet in the river hills, but since the smooth plains of this subsection extend south along minor interfluves, the resulting boundary is an extremely irregular line. The line also marks in a general way the southern limit of glacial deposits, but in several places glacial deposits occur south of the line and, conversely, in several places they have been removed by postglacial erosion north of the line. The western boundary is a rather straight line drawn at 150 feet of local relief, separating the lower relief of the Claypan Till Plains from the hills along the Chariton River. The boundary is usually readily visible in the landscape and also serves as the drainage divide (Grand Divide) between the Chariton River and the Salt River and other tributaries of the Mississippi. The northern boundary runs mainly up the South Fabius River valley in Knox County, and then roughly on the drainage divide between it and the Middle Fabius. The line is drawn where a landscape with significant tracts of flat plains and former prairies gives way to a series of broad, flat, parallel interfluves in the Wyaconda Hills. The eastern boundary is drawn, in general, at 150 feet of local relief, where the low relief of the Claypan Till Plains changes to a more deeply dissected topography of the Mississippi River Hills Subsection. In some places this change is abrupt, as at Bowling Green in Pike County and Center in Ralls County. In most places, though, the change is transitional and the boundary extends westward along major stream valleys, such as those of the Salt and Cuivre Rivers.

CLIMATE

Mean annual precipitation is 38–39 inches. The wettest months are May–July and September, and 63 percent of the annual precipitation occurs during the six warmer months of the year (at Paris). Annual snowfall range is 20–22 inches. Mean January minimum daily temperature is 15–16°. Mean July maximum daily temperature is 88–89°. The growing season averages 200–210 days. Microclimatic variations are insignificant in this subsection of very low relief.

TOPOGRAPHY AND GEOLOGY

The subsection is underlain by horizontally bedded Mississippian and Pennsylvanian sedimentaries, but rarely are they exposed anywhere, and their influence on surface features is minimal. Overlying the sedimentaries are pre-Illinoisan glacial till and a thin veneer of loess (less than 5 feet thick). The surface is formed almost completely from the glacial till. Postglacial fluvial and eolian processes may have further smoothed an already smooth till plain surface. Long-term pedological processes on the smooth, poorly drained surface created soils with well-developed claypans. This surface is apparently resistant to fluvial erosion and may be responsible for the lack of stream dissection, despite the subsection's proximity to the Missouri and Mississippi Rivers. The subsection has local relief less than 100 feet and over large areas does not exceed 20 feet within 1 square mile. It is the largest area of low relief of any upland in Missouri. The northern portions in Shelby and Knox Counties have slightly greater relief than the southern portion in Audrain and adjacent counties. Clay of refractory quality has been mined in Audrain, Callaway, and Montgomery Counties. Historic coal mines are in several counties in the subsection. Limestone is quarried in Knox and Shelby Counties where bedrock is exposed.

SOILS

Soils in this subsection are nearly all very deep. Most are somewhat poorly to poorly drained, with clayey subsoils. The claypan soils of the Putnam, Mexico, and Leonard series have dark silt loam surface layers underlain with silty clay to clay subsoils, with perched water tables in the winter and spring. Putnam soils are on the flat interfluves, Mexico soils are on broadly convex divides, and Leonard soils are on gently sloping headslope positions. The loess, in which the Putnam and Mexico soils formed, thins downslope, and Armstrong soils on the moderately sloping backslopes formed in glacial till. Floodplains are narrow and inextensive, with very deep, silty soils such as Belknap on the low floodplains and Moniteau on the slightly higher surfaces.

HYDROLOGY

The subsection comprises the upper portion of the drainage basins of the Salt and Cuivre Rivers (both tributaries to the Mississippi River), and on the south the headwaters of streams that lead to the lower Missouri River. The western boundary of the subsection is basically the Grand Divide, here defined as the divide between the Salt and Chariton drainage basins. Stream channels are virtually everywhere in silts and clays that are the weathered products of glacial till and loess. Since agricultural development, streams carry a high suspended-sediment load. Bedrock is rarely encountered. Channels are naturally intensely meandering and have very low gradients and stable banks, except in some long stretches where they have been straightened by channelization. In channelized stretches, stream equilibrium has been destroyed and local degradation and aggradation occur. In general, streamflow is highest in spring and early summer. Floods are common, and there are few flood-

Jim Rathert

Large, open-grown savanna and woodland trees with their spreading crowns may be seen on pastures in more dissected portions of the Claypan Till Plains.

control works to mitigate them. Smaller streams are intermittent and ephemeral, and perennial streams may have very low flows or become disconnected pools during summer dry periods. Springs are very small and rare. The subsection has no natural ponds or lakes, although flat surfaces may be saturated for extended periods in late winter and spring due to the impeding of soil-water percolation by claypans. Water can also stand for several days in low spots on the flat surface ("inflooding") due to high-intensity summer rains. Some of the broad alluvial bottoms have wetlands. Numerous ponds and lakes have been constructed for livestock watering, municipal water supplies, irrigation water supplies, and recreation. Stream water quality may be affected by agricultural runoff, including livestock operations, especially during low-flow periods. Groundwater is notably saline in the northern part of the subsection, and this condition encourages the development of surface-water supplies.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The region was formerly more than 75 percent tallgrass prairie. Seasonally inundated wetlands were common throughout the prairie. Valleys were timbered in oak savanna and woodland and contained marshes and bottomland forests.

Current. Today, the region is more than 50 percent cropland. Most former prairies are now used extensively for corn and soybeans. Extensive pasture and hay land form the balance, especially on more rolling lands near streams. Very little natural vegetation remains. Only one prairie remnant is known, and most woodlands are mixed invasive timber such as elm, hackberry, and locust.

Major Natural Community Types

Hardpan Prairie

Ephemeral Marsh/Sedge Meadows

Pin Oak, Post Oak, Cherrybark Oak Lowland Flatwoods

Central White Oak Dry-Mesic Glaciated Woodland

Rare or Restricted Natural Communities. Hardpan prairies, lowland flatwoods, and widespread ephemeral wetlands on glacial materials were confined mainly to this subsection in Missouri; few remnants are known. All natural communities are rare in this ecoregion today.

NATURAL DISTURBANCES

Fire, grazing, and periodic ponding of water would have restricted tree growth and favored the dominance of grassland in this ecoregion.

RARE OR ENDANGERED SPECIES

The Claypan Till Plains Subsection has more than 100 records of 34 state-listed species, a low number relative to the subsection's size. Most species are associated with upland prairie or stream habitats. Two federally listed species are the Indiana bat *(Myotis sodalis)* and the Topeka shiner *(Notropis topeka)*. Southern arrowwood *(Viburnum dentatum* var. *deamii)* has its only Missouri records in this subsection.

NATURAL AREAS

The subsection has two natural areas. Tucker Prairie is the only claypan prairie remnant known. Rocky Hollow Natural Area has oak woodland represented.

PUBLIC LANDS

The subsection has more than 9,000 acres of public land, more than 6,000 acres of which is owned and managed by the Missouri Department of Conservation. Prominent Conservation Areas include Atlanta, Hunnewell Lake, Ranaker, Rocky Fork Lakes, and Whetstone Creek. The Cedar Creek District of the Mark Twain National Forest has more than 3,000 acres in this subsection. A small portion of Rock Bridge State Park extends into this ecoregion.

HUMAN GEOGRAPHY

Demographics. The southern and eastern margins of the subsection were occupied by Indians for long periods of time. Important routes crossed the uplands. American settlement began on the southern margins after 1815 and on the eastern margins in the 1820s. Most of this early settlement was for corn, cattle, and hog raising. In the 1830s settlement spread into the broad uplands. By the time of the Civil War, most of the subsection was occupied by farms, many with slaves. Most of the people who settled the region before the Civil War were from Kentucky and Tennessee. After the war, settlers came from other states and included contingents

Jim Rathert

Tucker Prairie, along I-70 near Kingdom City, is the only known remnant of the once extensive hardpan prairies of the Claypan Till Plains Subsection.

of Europeans. Rural population reached its maximum around the turn of the century and has been declining ever since. Town growth has offset rural loss in a few counties. Most rural parts have only about one-half of their population in 1900. Loss of population has placed great pressure on local services and institutions.

Economics and Land Use. The Civil War disrupted society and economy especially on the southern and eastern margins. After railroads came in the 1860s and 1870s, agriculture throughout the region became more commercialized, with an emphasis on wheat, corn, cattle, and mules. The flattest lands, however, were not broken for row crops until near the turn of the century or later. In the twentieth century farm and field sizes have grown much larger and soybeans have been introduced. Irrigation, mostly by sprinkler, increases the reliability of high yields. The subsection's economy is based on agriculture, including both crops (soybeans, corn, wheat, and sorghum) and livestock (cattle, hogs, and horses). Sloping land and even some of the poorly drained flat land is in pasture. The relatively small amount of timber is restricted to more broken areas. Manufacturing, much of it based on clay resources and agriculture, is at Mexico, Fulton, Centralia, Moberly, Macon, Kirksville, and smaller places. Commercial activity takes place at these and smaller towns. Coal mining has ceased, but clay mining continues.

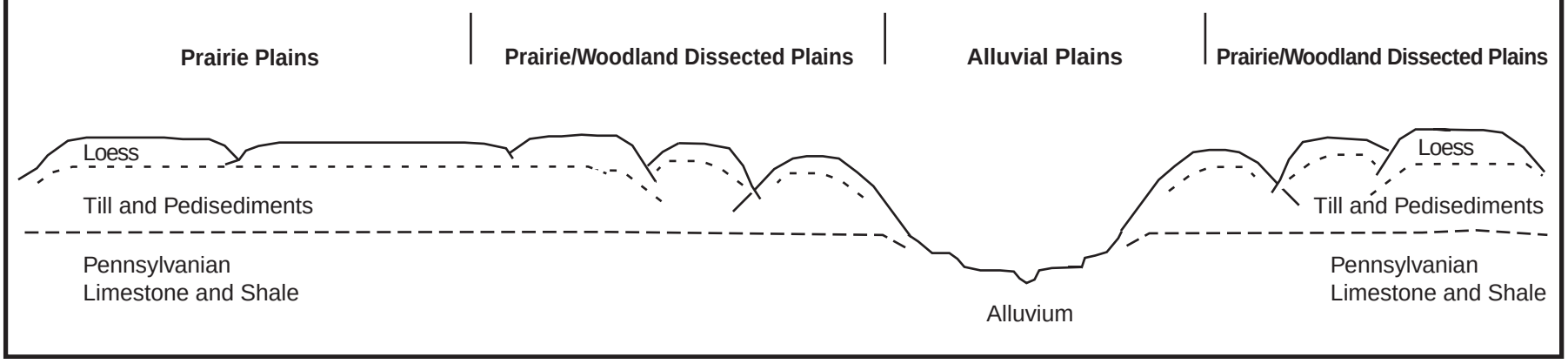
LANDTYPE ASSOCIATIONS

The Claypan Till Plains Subsection is subdivided into eight landtype associations (LTAs). These LTAs are differentiated based mainly on the amount of relief and surface roughness and corresponding soil and historic vegetation patterns. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

Because of the high degree of agricultural conversion, very little natural vegetation remains. Only one claypan prairie remnant is known, and other natural communities are also rare. A region-wide effort to conserve glacial prairies and wetlands and restore glacial prairie/woodland landscapes is needed.

LANDTYPE ASSOCIATIONS IN THE CLAYPAN TILL PLAINS SUBSECTION



(see landtype associations map pgs. 66–67)

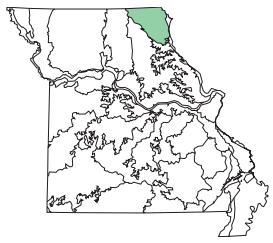
LANDTYPE ASSOCIATIONS IN THE CLAYPAN TILL PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP6a North Fork Salt River Alluvial Plain	The LTA occupies the flat alluvial plain of the North Fork of the Salt River in Shelby and Knox Counties where it is at least 1 mile wide.	The LTA consists of a flat alluvial plain averaging 1–2 miles wide with few terraces. Alluvium grades imperceptibly with colluvium washed from valley sides. The North Fork channel has been straightened by channelization, causing aggradation and increased flooding at the lower end of the straightened channel. Soils are mainly poorly drained silt loams and silty clay loams formed in fine-textured alluvium. Historically the LTA was a mosaic of wet prairie, marshes, and bottomland woodland and forest. Today these drained bottoms are mainly croplands with narrow bands of riverfront timber.
TP6b Grand Prairie Prairie Plain	The LTA occupies the large, flat upland divide south of the Elk Fork of the Salt River and west of the South Fork of the Salt River in western Audrain, northern Callaway, eastern Boone, and southern Monroe Counties. An extension projects northward along the drainage divide in Randolph County. Moberly, Mexico, Fulton, and Columbia lie on margins of the plain. The eastern boundary is drawn where relief drops to less than 20 feet. All other boundaries mark an increase in local relief to more than 75 feet.	The large LTA is a minimally dissected plain with less than 75 feet of local relief. Much of the plain has simple drainageways occupying swales, but true streams in valleys are very slightly cut into the surface. The plain is underlain by glacial till with a thin cover of loess that has largely been plowed into the till layer. Soils are mainly poorly drained prairie soils with claypans. Historically the LTA was more than 75 percent prairie (known as the Grand Prairie for its great extent) with scattered ephemeral wetlands and narrow bands of flatwoods and woodlands along the drainageways and valleys. Today cropland, increasingly irrigated, dominates the former prairie flats, while pasture has replaced the woodlands. Small, isolated blocks of timber, composed mainly of invasive species, remain. Very little natural vegetation is present. Economic development is moderate around the cities and along the highways.
TP6c Audrain Flat Prairie Plain	The LTA occupies a very flat plain south of the main Salt River and east of the South Fork of the Salt River, chiefly in eastern Audrain County but extending into adjacent counties. The western boundary marks the end of the remarkably flat surface. The other boundaries are drawn where relief increases to more than 75 feet. Northern and southern boundaries are based on a change in relief to over 75 feet.	The LTA encompasses the largest expanse of flat uplands in Missouri. It has less than 20 feet of local relief over an area of 100 square miles. Relief increases somewhat to the margins. Drainage lines are poorly developed and rainwater can remain for some time on the surface before infiltrating or draining off. Soils are formed in thin loess over till and have distinct claypans that impede both drainage and the rise of subsurface moisture. The LTA was formerly more than 90 percent prairie with scattered ephemeral wetlands and narrow belts of woodlands in drainageways. Today this flat landscape is over 90 percent cropland with occasional pastures and small, isolated woodlots. Numerous prairie chicken leks were present in this LTA until the 1980s, but they have likely been extirpated from this landscape.
TP6d Cuivre River Prairie Plain	The LTA occupies a minimally dissected plain associated with the headwaters of the Cuivre River system mainly in Audrain, Pike, Montgomery, and Warren Counties. It is an irregularly shaped LTA with fingers running down the flat divides between the forks of the Cuivre. The northwestern boundary marks the flattening out of the surface to a relief less than 20 feet. Other boundaries mark the change to landscapes of more than 75 feet and usually much more.	The LTA consists of broad, flat upland divides with local relief generally less than 75 feet. The surface is cut with drainageways in very shallow valleys. Clay is mined on the southern margins. Soils are formed in thin loess over till and have distinctive claypans that impede drainage. Historically, the LTA was more than 75 percent prairie grading into oak savannas, flatwoods, and bottomland woodland. Today, most of the former prairie is cropland. Pasture and occasional dense invasive timber stands are scattered along streams. Commercial development is taking place along I-70 on the southern border.

(table continued on pg. 46)

LANDTYPE ASSOCIATIONS IN THE CLAYPAN TILL PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP6e North Fork Salt River Prairie Plain	The large LTA occupies the very slightly dissected upland plain on both sides of the North Fork of the Salt River and extends along the narrow divide between the Salt and Chariton River systems at Macon. The LTA occupies much of Adair, Knox, Shelby, and Macon Counties. Boundaries are drawn where local relief increases to more than 100 feet. The western boundary is along the drainage divide with the Chariton drainage basin. The long northwestern boundary is drawn where this subsection's significant tracts of flat plains give way to a series of broad, parallel interfluves and intervening valleys in the Wyaconda Hills Subsection.	The LTA consists of flat uplands slightly dissected by shallow valleys with less than 100 feet of local relief. The surface is constructed on till with a slight loess cover. Soils tend to be deep with claypan horizons. Historically, the LTA was over 75 percent tallgrass prairie that graded into oak savannas and flatwoods along stream courses. Today, the southern half of the LTA is dominated by cropland with scattered pasture, and the somewhat more dissected northern half is dominated by pasture with scattered cropland. The large grassland landscape along the Adair-Knox county line is a focal area for prairie chicken and grassland ecosystem restoration.
TP6f Upper Salt River Prairie/ Woodland Dissected Plain	The LTA occupies a slightly dissected plain along the Middle Salt Fork and Elk Fork in Monroe, Randolph, and Macon Counties. Boundaries are drawn at a local relief of 75 feet to separate this dissected plain from the surrounding flat plains. The downstream boundary is drawn where relief increases to 150 feet.	The LTA consists of broad, rolling, occasionally flat uplands with moderate slopes and shallow stream valleys in glacial till. Local relief is 75–150 feet and is deep enough to expose sedimentary strata on valley sides. Historically the LTA consisted of prairie openings on the flat and rolling uplands that merged into oak savannas, woodlands, and flatwoods in lower locations. Valley floors also had bottomland prairies and wetlands. Today the LTA is mainly cool-season pasture, with cropland concentrated on bottomlands and flatter uplands. Numerous small, isolated woodlands occur; several, including Rocky Hollow Natural Area, are considered outstanding.
TP6g Monroe City Flat Prairie Plain	The LTA occupies a narrow, flat upland divide between the lower Salt and North Rivers. Boundaries are drawn to encompass a flat upland with less than 75 feet of local relief. US 36 follows the length of the upland.	The LTA consists of a flat upland with less than 75 feet of local relief that drops off sharply into neighboring valleys with high-gradient streams. The upland is underlain by limestones with thin and patchy till and loess. The eastern end has numerous sinkholes and other karst features. Formerly prairie, the LTA today is more than 80 percent cropland with scattered cool-season pasture. Urbanization at Hannibal affects land use in the eastern end.
TP6h North Fork Salt River Prairie/ Woodland Dissected Plain	The LTA occupies a strip of somewhat hilly and dissected lands along the North Fork of the Salt River mostly in Shelby and Macon Counties. Boundaries are drawn to encompass a dissected surface with more than 75 feet of local relief, excluding the alluvial plain of the North Fork. On the downstream end the boundary is drawn at 150 feet.	The LTA consists of a weakly dissected plain surface with rounded ridges, moderate slopes, and shallow stream valleys in glacial till. Dissection is strong enough, however, to expose sedimentary strata on valley sides. Historically the LTA had prairie openings on the rounded ridges that gave way to oak savannas, woodlands, and flatwoods on lower slopes. Today the LTA is mainly cool-season pasture with cropland concentrated in alluvial plains. Small, isolated woodlands also occur. Four sites for southern arrowwood constitute the only known sites in Missouri.

TP7
WYACONDA RIVER DISSECTED TILL PLAINS SUBSECTION

(see map pg. 70)



GENERAL DESCRIPTION

The Wyaconda River Dissected Till Plains Subsection consists of the slightly dissected till plain of northeastern Missouri. Although relief is usually less than 150 feet, little of the flat till plain surface remains. Postglacial stream erosion has transformed the surface into a series of parallel, low-relief ridges and valleys carved from glacial till. Before permanent settlement natural vegetation was a mosaic of upland prairies and valley-side woodlands arranged in linear patterns according to the subparallel drainage pattern. Most of the subsection today is a mixture of pasture and field crops.

LOCATION AND BOUNDARIES

The subsection lies in extreme northeastern Missouri. It comprises all of Scotland County, most of Clark, Lewis, and Schuyler Counties, and smaller portions of Adair, Knox, Shelby, and Marion Counties. Its short northwestern boundary is the major drainage divide (Grand Divide) separating the Mississippi River tributaries of this subsection from the Chariton River. The southern boundary across Schuyler, Adair, and Knox Counties is essentially a line along the South Fabius River, drawn, in principle, to separate this subsection's landscape of rounded, narrow interfluves from an area with broader and flatter interfluves that have distinctive claypan soils. The eastern boundary is the Mississippi River alluvial plain. The northern boundary is the Iowa state line. The subsection extends well into Iowa.

CLIMATE

Mean annual precipitation is 38 inches. The wettest months are April–September, and an impressive 67 percent of the annual precipitation occurs during the six warmer months of the year (at Memphis). Annual snowfall is 23–24 inches. Mean January minimum daily temperature is 14–15°. Mean July maximum daily temperature is 88°. The growing season averages 200 days. Microclimatic variations are weakly developed in this subsection of moderate to low relief.

TOPOGRAPHY AND GEOLOGY

The subsection is underlain by upper Mississippian carbonate formations in the southern half and lower Pennsylvanian cyclic sedimentaries in the northern half. They are essentially horizontally bedded, but they are rarely exposed and have hardly any effect on surface configuration and processes. Overlying them are pre-Illinoisan glacial till 100–300 feet thick (thinner near the Mississippi River) and a thin veneer of loess (less than 5 feet thick). The surface is formed almost completely from glacial till. Postglacial fluvial processes have created a striking "corrugated" topography of subparallel streams trending southeastward. Natural and human-induced erosion has removed upland loess and redeposited it in broad valley bottoms. Local relief is less than 150 feet and on smoother divides less than 75 feet. In contrast to the Claypan Till Plains Subsection to the south, little of the former flat upland till plain surface remains, having been reduced to very smooth, rounded ridges with slopes gentle enough for row crops and improved pasture. Most of the surface is in gentle slopes and broad alluvial bottoms. No minerals of consequence are produced in the subsection.

SOILS

Soils in this subsection are nearly all very deep. Most upland soils range from moderately well to somewhat poorly drained, with silt loam surface layers and clayey subsoils. Upland soils on interfluves, such as the Adco series, have formed in loess and have silty clay subsoils. Soils on backslopes have formed in glacial till and have thin (Keswick, Lindley series) to moderately thick (Armstrong series) to thick (Gara series) surface layers, depending on whether the native vegetation was timber, savanna, or prairie. The glacial till soils have clay loam to clay subsoils. Floodplains are narrow and inextensive, with very deep, silty soils, such as Fatima, and soils with silty clay loam subsoils, such as Arbela.

HYDROLOGY

The subsection comprises the major portion of the drainage basins of the Fabius, Wyaconda, and Fox Rivers in Missouri. Stream channels are everywhere in silts and clays, which are the weathered products of glacial till and loess. Streams carry a high suspended load, especially after periods of runoff. Channels are naturally intensely meandering and have very low gradients and stable banks. In some long stretches where they have been straightened by channelization, however, stream equilibrium has been destroyed and local degradation and aggradation occur, the latter usually at the end of a channelized stretch. In general, streamflow is highest in spring and early summer. Flooding is common from high-intensity rains; few flood-control works mitigate natural flooding. Smaller streams are intermittent and ephemeral, and even streams considered as perennial may become a series of disconnected pools after protracted dry spells. Springs are very small. The subsection had no natural ponds or lakes, although water can stand for several days in swales on uplands and in bottomlands after high-intensity summer rains. Ponds and small lakes constructed for stock watering and municipal water supplies are

Missouri Department of Conservation

Broad rolling uplands, gentle slopes, and broad valleys are characteristic of the Wyaconda River Dissected Till Plains Subsection.

common. Stream water quality may be affected by agricultural runoff, including livestock operations. Groundwater from Pennsylvanian bedrock sources may be saline, and this encourages the development of dependable surface-water supplies.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The high, smooth interfluves of the ecoregion were formerly tallgrass prairie. Prairie graded into oak savannas and woodlands on steeper lands, especially on the northeastern sides (the fire shadow sides) of linear stream valleys. Bottomlands were a mixture of lowland prairie, marshes, and bottomland woodland and forest.

Current. The region is thoroughly dominated by farms with cropland occupying bottomlands and smooth uplands, and nonnative, cool-season pasture on the more sloping lands. Fescue or brome pastures are the most common cover today. Pastures often have scattered, old savanna trees. Prairies and true savannas and woodlands are virtually absent. Invasive timber has grown up along fencelines and in abandoned farm ground. Second-growth oak and mixed-hardwood woodland or forest are confined to patches in the roughest land. Remnant natural communities are rare, fragmented, and scattered.

Major Natural Community Types

Midwest Dry-Mesic Glaciated Prairie

Central Mesic Tallgrass Glaciated Prairie

Central Bur Oak Dry-Mesic Glaciated Savanna

Central White Oak Dry-Mesic Glaciated Woodland

Midwest White Oak–Red Oak Dry-Mesic Glaciated Forest

Bur Oak, Swamp White Oak, Shellbark Hickory Mesic Bottomland Woodland

Rare or Restricted Natural Communities. All natural communities on glacial materials are rare and scattered because of the almost complete land conversion to agriculture. Most communities native to this ecoregion were widespread across northern Missouri. Bottomland woodlands of bur oak, swamp white oak, and shellbark hickory may have been common here, but are very rare today. Streams are suffering from siltation and agricultural pollution. Some marshes occurred historically, but few quality remnants are known. Only two small prairie remnants are known and savannas and woodlands are virtually absent. Some forestlands have savanna or woodland restoration potential. Conservation of the region's native ecosystems will require restoration.

NATURAL DISTURBANCES

Drought and associated fire played key roles in the creation and maintenance of this prairie and woodland mosaic. Grazing by deer, elk, and bison, as well as wind and ice storms, have also been factors. Floods shaped the diversity of wetland communities.

RARE OR ENDANGERED SPECIES

The subsection contains only 64 records of 30 state-listed species, a relatively low number for its size. Most of the species are associated with upland prairie, woodland, or stream habitats; many of these are confined to glaciated northern Missouri. Three species of federal concern are known: Indiana bat *(Myotis sodalis),* Topeka shiner *(Notropis topeka),* and bald eagle *(Heliaeetus leucocephalus).*

NATURAL AREAS

The Wyaconda River Dissected Plains has only one designated Natural Area, Des Moines River Ravines. It includes representative examples of upland forest communities.

PUBLIC LANDS

There are over 17,000 acres of public land in this subsection. The Missouri Department of Conservation owns almost all of it, including Clark, Deer Ridge, Fox Valley Lake, and Indian Hills Conservation Areas.

HUMAN GEOGRAPHY

Demographics. The prairies and woodlands of the subsection were occupied by Indians (Sauks, Foxes, and Ioways) for long periods of time. American settlement began along the valleys in the late 1820s and 1830s and spread generally across the region in the 1840s. Settlers came from a variety of states and included contingents of German immigrants. Rural population reached its maximum at the beginning of the twentieth century and has been declining ever since. Town growth has been slight and not nearly enough to offset the large rural population losses. Most counties have less than half of their peak populations of nearly a century ago. Some rural townships have only one-sixth of their former populations. As a consequence, local institutions and services are under great stress.

Economics and Land Use. Early settlement centered on small fields of corn and other grains and livestock on unfenced prairies. After railroads came in the 1860s and 1870s, agriculture became more commercialized with an emphasis on wheat, corn, cattle, and hogs. The subsection became part of the "Corn Belt" of the Midwest. In the twentieth century, mechanization and national economics forced farm and field sizes to become much larger, and soybeans have become a dominant crop. A large proportion of prime farmland is now in field crops, especially soybeans, corn, and wheat. Other land is in improved pasture. The relatively small amount of timber is restricted to steeper slopes, eroded lands, and marginal soils, and strips along streams. The subsection's economy is completely oriented to agriculture, including both crops (soybeans, wheat, corn, and hay) and livestock (cattle, hogs, and sheep). The very small towns have not developed any commercial, manufacturing, or service activities other than to serve the small rural populations of their counties.

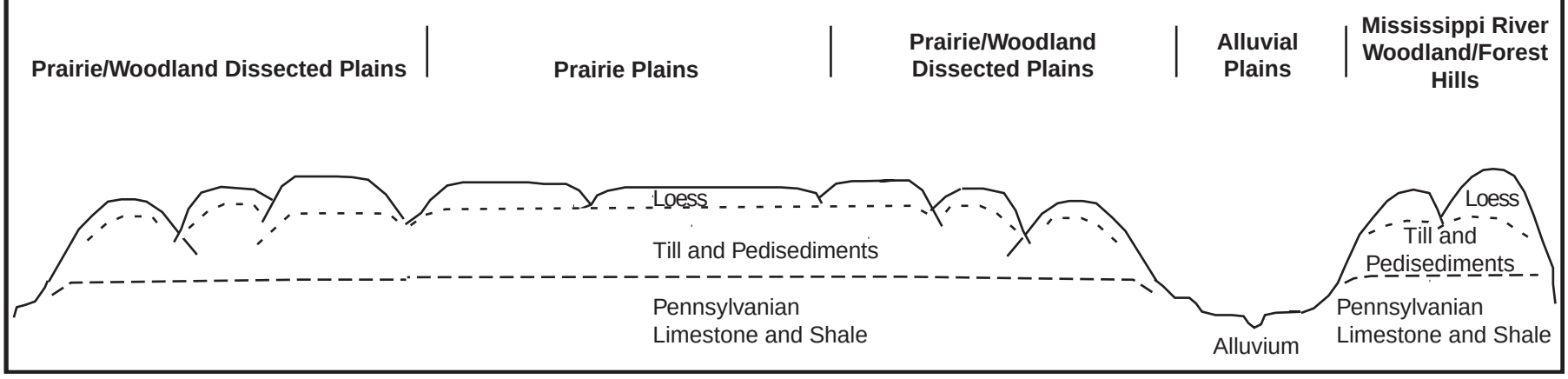
LANDTYPE ASSOCIATIONS

The Wyaconda River Dissected Till Plains Subsection is subdivided into nine landtype associations (LTAs). These include flat upland and lowland plains, as well as more rolling hills along the streams. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

Because of the high degree of agricultural conversion, very little natural vegetation remains. Only two typical glacial prairie remnants are known. Two outstanding forests are conserved, but no examples of savannas or woodlands once so widespread are known. A regional-scale effort to conserve glacial prairies and wetlands and to restore glacial prairie/woodland landscapes is needed.

LANDTYPE ASSOCIATIONS IN THE WYACONDA RIVER DISSECTED PLAINS SUBSECTION



(see landtype associations map pg. 70)

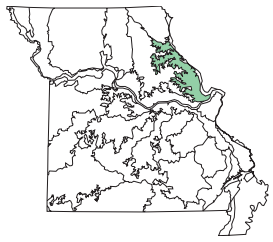
LANDTYPE ASSOCIATIONS IN THE WYACONDA RIVER DISSECTED TILL PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP7a Northeast Missouri Alluvial Plains	The LTA occupies five separate alluvial plains of the South, Middle, and North Fabius Rivers and the Wyaconda River where they are at least 1 mile wide.	The LTA consists of flat alluvial plains and terraces with somewhat poorly and poorly drained, very deep soils formed in silty, loamy, and clayey alluvium. Stream channels were formerly intricately meandering, but most have been straightened and their gradients steepened, which has destroyed stream equilibrium. Historically the LTA was a mosaic of wet prairie, marshes, and bottomland woodland. Today these landscapes are nearly all cropland.
TP7b Lancaster Prairie/ Woodland Dissected Plain	The LTA occupies a rolling upland in the headwaters of all forks of the Fabius River mostly in Schuyler and Scotland Counties. Boundaries are drawn to enclose an area with local relief over 100 feet. The western boundary is the major regional drainage divide with the Chariton system. The northern boundary is the Iowa state line.	The LTA consists of broad, rounded, subparallel ridges that give way to moderately sloping and slightly dissected valleys along several subparallel streams. Local relief is generally 100 feet. Underlying materials are thick deposits of glacial till with a thin veneer of loess. Streams are small in average discharge and mostly channelized. Broadest uplands were formerly prairie that graded into oak savanna and woodland on slopes. The bottomlands included wetlands. Today this landscape is over 90 percent cool-season pasture with cropland in the broad bottoms and smoothest uplands. Indian Hills Conservation Area is in the LTA.
TP7c Middle Fabius River Prairie Plains	The LTA occupies two separate, minimally dissected uplands between the South Fabius and North Fabius Rivers. Boundaries are drawn to enclose upland plains with less than 100 feet of local relief.	The LTA consists of flat to very gently rolling drainage divides with thin loess over glacial till. Local relief is less than 100 feet and usually less than 50 feet. Formerly the LTA was more than 75 percent tallgrass prairie grading into oak savannas. Today the LTA is mainly cool-season pasture and cropland with narrow bands of mainly invasive timber in the shallow valleys.
TP7d Wyaconda River Prairie Plains	The LTA occupies a minimally dissected upland associated with the Wyaconda River and its tributaries in Scotland, Clark, and Lewis Counties. Long, narrow uplands extend from headwaters on the Iowa state line southeastward almost to the Mississippi River. A disconnected tract lies north of Canton. Boundaries are drawn to enclose upland plains with less than 100 feet of local relief. The northern boundary is the Iowa state line.	The LTA consists of flat to gently rolling drainage divides with thin loess over glacial till. Local relief is less than 100 feet and generally less than 50 feet. Formerly the LTA was more than 75 percent tallgrass prairie grading into oak savannas. Today the landscape is mainly cool-season pasture and cropland with narrow bands of mainly invasive timber along stream courses. The LTA is almost completely in agriculture and lacks any appreciable amount of public land.
TP7e Fox River Prairie Plain	The LTA occupies a small, narrow, flat upland between the Fox and Des Moines Rivers in Clark County. Boundaries are drawn to enclose a plain with less than 100 feet of local relief.	The LTA consists of a small, flat to slightly dissected upland with thin loess over glacial till. Local relief is less than 100 feet. Formerly the LTA was more than 75 percent prairie and the remainder oak savannas and groves. Today the landscape is completely in cropland with scattered pastures and woodlots.

(table continued on pg. 50)

LANDTYPE ASSOCIATIONS IN THE WYACONDA RIVER DISSECTED TILL PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP7f Wyaconda River Prairie/ Woodland Dissected Plains	The LTA occupies belts of dissected plains along the Wyaconda River from Scotland County into Clark and Lewis Counties. Boundaries are drawn to encompass lands with over 100 feet of local relief. The eastern boundary is drawn to exclude the loess-covered blufflands near the Mississippi River.	The LTA consists of broad, rounded divides that give way to gently sloping and moderately dissected valleys along numerous subparallel streams of the Wyaconda system. Local relief is 100–150 feet, with the greater amount closer to the Mississippi River. The LTA is underlain by glacial till that thins closer to the Mississippi River, exposing sedimentary strata along the valley sides. The LTA also has a cover of loess on ridges that thickens closer to the Mississippi River. Broadest uplands were formerly tallgrass prairie that graded into oak savanna and woodland. The bottoms had wetlands. Today the LTA is more than 75 percent cool-season pasture with cropland in the broad bottoms and smoothest uplands. Substantial patches of second-growth forest occur in more sloping lands, especially closer to the Mississippi River.
TP7g Fabius River Prairie/ Woodland Dissected Plains	The LTA occupies dissected plains associated with all forks of the Fabius River, chiefly in Lewis and Marion Counties. Boundaries generally are drawn to enclose dissected lands with more than 100 feet of local relief, but excluding the loess hills along the Mississippi River. The southern boundary is drawn for convenience along the South Fabius River in Marion County to mark a change to a landscape of greater relief.	The LTA consists of broad, rounded divides that give way to moderately sloping and dissected valleys along numerous subparallel streams trending southeastward. Local relief is 100–150 feet, with the greater amount closer to the Mississippi River. The LTA is underlain by glacial till that thins closer to the Mississippi River and exposes sedimentary strata along the valley sides. The LTA also has a cover of loess on ridges that thickens closer to the Mississippi River. Broadest uplands were formerly tallgrass prairie that graded into oak savanna and woodland. The bottoms had wetlands. Today the LTA is mostly in cool-season pasture with cropland in the smoothest uplands and on drained bottomlands. Substantial amounts of second-growth forest occur on more broken lands closer to the Mississippi River.
TP7h Mississippi River Woodland/ Forest Hills	The LTA occupies a very narrow belt of loess-covered river hills bordering the Des Moines River and the Mississippi River alluvial plain as far south as LaGrange. The western boundary is drawn where relief decreases to less than 150 feet and loess is not influential in shaping landforms. The eastern boundary is the bluff line.	The LTA consists of loess-capped blufflands with a local relief of 150–200 feet. Numerous steep-sided, narrow valleys have outcrops of sedimentary strata on their valley sides. Till is more common in the north. Loess has washed into the valleys. Historically the LTA was timbered in oak and mixed-hardwood woodland and forest. Today it is mainly pasture on gentler slopes and dense second-growth forest elsewhere. US 61 passes through these blufflands.
TP7i Fox River Prairie/ Woodland Dissected Plains	The LTA occupies belts of dissected plains along the Fox River in Clark County in extreme northeastern Missouri. Boundaries are drawn to encompass lands with over 100 feet of local relief, but excluding the loess-covered blufflands on the east.	The LTA consists of broad, rounded divides that give way to gently sloping and moderately dissected valleys. Local relief is 100–150 feet. The LTA is underlain with glacial till with a thin veneer of loess on the uplands. The long, narrow uplands were formerly in tallgrass prairie that graded into barrens, oak savanna, and woodland. Bottomlands had some wetlands. Today the LTA is mostly in cool-season pasture and cropland, but substantial tracts of second-growth forest occur on steeper slopes. The LTA includes several tracts of conservation land.

TP8
MISSISSIPPI RIVER HILLS SUBSECTION

(see map pgs. 68–69)



GENERAL DESCRIPTION

The Mississippi River Hills Subsection consists of a broad belt of hills, valleys, and blufflands along the western side of the Mississippi River from the North River southward to the Missouri River. Topography ranges from moderately rolling to steep and rugged; local relief averages 150–250 feet. Loess mantles the entire subsection. Carbonate bedrock is exposed on steeper slopes and locally creates karst tracts. Presettlement vegetation was oak and mixed-hardwood woodland and forest. Most of the subsection is in farms, mainly livestock, with crops on better soils. Urbanization from the St. Charles–St. Louis metropolitan area and around Hannibal exerts development pressure.

LOCATION AND BOUNDARIES

This subsection lies along the Mississippi River in northeastern Missouri. It comprises portions of all river border counties (Marion, Ralls, Pike, Lincoln, and St. Charles) and small portions of Lewis, Knox, Shelby, Monroe, Audrain, Montgomery, and Warren Counties. Its eastern boundary is the bluff line that marks the alluvial plain of the Mississippi River. Its western boundary is a highly crenulated line extending farther away from the river in the deep valleys of Mississippi tributaries and approaching the river along smooth interfluves. The boundary is drawn at approximately 150 feet of local relief, but in most places this is gradational and imprecise in the landscape. The northern boundary runs along the South Fabius River valley where this dissected hills landscape gives way to a series of broad, rounded, parallel interfluves in the Wyaconda Hills Subsection. The southern boundary in western St. Charles County is drawn to separate this subsection from the more rugged river hills of the Outer Ozark Border Subsection. In central St. Charles County the boundary is the Missouri River bluff line. The southern boundary across St. Charles County also marks in general the southern limit of glacial deposits in that county.

CLIMATE

Mean annual precipitation is 39 inches. The wettest months are April–September, and 60 percent of the annual precipitation occurs during the six warmer months of the year (at Bowling Green). Annual snowfall ranges from 23 inches in the north to 20 inches in the south. Mean January minimum daily temperature is 15–17°. Mean July maximum daily temperature is 88°. The growing season averages 200–210 days. Microclimatic variations are significant locally in this subsection of moderately high relief.

TOPOGRAPHY AND GEOLOGY

The subsection is dominated structurally by the Lincoln Fold, a northwest-southeast trending anticline. Its crest extends from southeastern Lincoln County to central Marion County and parallels the Mississippi River. Strata dip to the northeast and the southwest on either side of this anticline. Subsequent breaching by geologic erosion has caused older formations otherwise restricted to the Ozark Highlands Section to be at the surface. Thus, a major part of this subsection is a landscape and environment similar to that of the Outer Ozark Border. The underlying rocks in the central part of the subsection (Lincoln, Pike, and Ralls Counties) are Ordovician sandstones and limestones, Silurian-Devonian dolomites, and Mississippian cherty limestones (Burlington Formation). The carbonate rocks are soluble to varying degrees, and karst features are prominent locally, as in Lincoln County and around Palmyra and Hannibal. Local relief is generally between 200 and 350 feet. Steep-sided knobs and isolated ridges are formed on local occurrences of the strong Burlington Formation in Lincoln and Pike Counties. Some bluff heights reach 350 feet above the Mississippi River alluvial plain. Rock-faced bluffs are also prominent along the Salt River. North of Palmyra and south of the Cuivre River the subsection's surface is mostly derived from pre-Illinoisan glacial till. Relief is less (150–250 feet) in these places, and slopes are much gentler. The entire subsection is mantled with loess, which reaches thicknesses of 25 feet on blufftops and ridges. Limestone is quarried (some of it for cement) in many locations in the blufflands.

Jim Rathert

Steyermark Woods Conservation Area contains rich mesic forests common to the deep protected ravines of the Mississippi River Hills Subsection.

SOILS

Soils in this subsection are highly variable, primarily due to the diversity of parent materials and landscape positions in the area. Upland interfluves are capped with loess, which decreases in thickness and increases in clay content from east to west. The forested loess bluffs above the Mississippi River are dominated by the very deep, silty, well-drained Menfro soils and the moderately well-drained Winfield soils. Farther west and south, soils on the loess-capped interfluves are dominantly the poorly drained Mexico soils with silty clay subsoils. Loess overlays bedrock in the easternmost areas and glacial till farther west, and these materials are exposed to soil formation on lower backslopes. Very deep, well-drained Goss soils were formed in the clayey, cherty, red limestone residuum, and glacial till soils, such as Armstrong and Keswick, with clay loam subsoils, were formed under forest or woodland vegetation, respectively.

HYDROLOGY

The subsection includes the lower parts of the drainage basins of the North, Salt, and Cuivre Rivers. Stream gradients are low to moderate in these hills. In some places stream channels encounter bedrock and carry a gravel bed load, especially in the Cuivre system, but most streams are dominated by the silts and clays brought to them by slope wash of the loess surface or from up-basin sources in the Claypan Till Plains Subsection. Streamflow is highest in spring and early summer and declines through summer to a fall and early winter minimum. Small streams may cease to flow in summer and become ephemeral. Floods can occur at any time but are most common in spring and summer from high-intensity rains. The only natural ponds are sinkhole ponds. To these have been added hundreds of ponds and lakes for stock watering, recreation, or residential development, the last concentrated in St. Charles and Lincoln Counties. Mark Twain Lake, a large multiple-purpose reservoir, is on the Salt River and partially regulates river discharge below the dam. Surface water quality may be locally degraded from agricultural runoff, including hog and cattle operations, and from urbanization, especially in St. Charles County. Groundwater is abundant from deep rock sources.

TERRESTRIAL NATURAL COMMUNITIES

Historic. Most of the region was historically in timber. Timberlands ranged from oak savannas with widely scattered trees on broad uplands, through open-oak woodlands, to dense well-developed forests of oak and mixed-hardwood species in more dissected areas. Prairie openings occurred on flatter uplands. Bottoms supported a mosaic of prairie, wetlands, and bottomland forest.

Current. The most deeply dissected areas in the subsection remain timbered in dense second-growth oak and mixed-hardwood forests. Some of the oldest and most productive forests in Missouri are in these locations. Uplands and broad bottoms have a mixture of fescue pasture and cropland. Bottomland forests occur mainly in small, isolated fragments. Glades are often overgrown with woody invaders, and the former prairie openings have been eliminated.

Major Natural Community Types

White Oak–Hickory Dry-Mesic Glaciated Forest

Midwest White Oak–Red Oak Dry-Mesic Glaciated Forest

Red Oak, Sugar Maple, Elm Mesic Glaciated Forest

Central Maple, Basswood Mesic Glaciated Forest

White Oak Central Dry-Mesic Glaciated Woodland

Chinquapin Oak–Ash/Little Bluestem Dry Limestone Woodland

White Oak–Mixed Oak/Redbud Dry-Mesic Limestone/Dolomite Forest

Red Oak, White Oak, Sugar Maple Mesic Limestone/
Dolomite or Sandstone Forest

Rare or Restricted Natural Communities. High-quality prairies are absent. Oak savannas and woodlands have turned into forest in the absence of fire or have been cleared for pasture. Glades are severely overgrown. The only shale glades known in Missouri are in this subsection. Large tracts of bottomland forest are rare. Unique sandstone glade and cliff communities are scattered throughout the subsection, including some of the most outstanding limestone cliffs in Missouri. Seeps and sinkhole ponds are rare and fragile. Mesic forests with a rich diversity of plant species occur in steep ravines and valleys. Caves are abundant in several karst landscapes. Stream communities have unique assemblages because of their proximity to the Mississippi River.

NATURAL DISTURBANCES

Fire and grazing by native herbivores created and maintained the oak savannas and woodlands of this landscape. Storm damage from wind or ice probably contributed to periodic openings in the canopy of the forests.

RARE OR ENDANGERED SPECIES

The Mississippi River Hills Subsection contains 116 records of 53 state-listed species. Four federally listed species from the region are bald eagle *(Heliaeetus leucocephalus),* gray bat *(Myotis grisescens),* Indiana bat *(Myotis sodalis),* and eastern prairie fringed orchid *(Platanthera leucophaea).* Three state-listed species are found only in this subsection, including a cave-dwelling pseudoscorpion *(Mundochthonius cavernicolus)* and a moss *(Orthotrichum elegans).* An exceptionally high number of listed species are associated with the streams of the region.

NATURAL AREAS

There are six designated Natural Areas in the Mississippi River Hills Subsection. Elmslie, DuPont, and George A. Hamilton Forest represent upland woodlands and forests of the region. Big Sugar Creek is an outstanding creek community. Sandy Creek Natural Tunnel has an outstanding geologic feature. Lincoln Hills is a landscape representative of oak woodland and forest, limestone glades, and a sinkhole pond.

PUBLIC LANDS

The subsection has more than 75,000 acres of public land, 52,000 acres of which are associated with Mark Twain Lake and managed by the U.S. Army Corps of Engineers. The Missouri Department of Conservation owns almost 17,000 acres. Conservation Areas include Anderson, Busch, Dupont, Hunnewell Lake, Logan, Ranaker, and Weldon Springs. Cuivre River and Mark Twain State Parks comprise almost 9,000 acres.

HUMAN GEOGRAPHY

Demographics. Indians of various nations, including Sauks, Foxes, and Illinois, lived in and used the lands of this subsection for long periods of time. Settlements were in the blufflands, and all of the region was used for hunting. The southern parts of the subsection lay within the sphere of the historic Cahokia urban complex. French moved along the Mississippi River in the eighteenth century and established trading posts at St. Charles and near the Salt River toward the close of that century. Common fields and other agricultural land use were in place by 1800. Americans with slaves began entering the southern parts before the end of the 1700s, but agricultural settlement began in earnest after the War of 1812. Settlement spread rapidly northward and reached the Iowa border by the end of the 1820s. The Americans who settled the subsection before the Civil War came largely from Kentucky and Virginia and brought slaves with them. Immigration after the Civil War was much reduced but included contingents of Europeans, mostly Germans. Population gradually built up through the nineteenth century and reached a maximum in rural areas by 1890 or 1900. During the twentieth century the rural population continuously declined. Growth of Hannibal and smaller towns has not fully compensated for the rural population loss. In the latter decades of the twentieth century population growth in St. Charles County has been exceptional and is now spreading into Warren and Lincoln Counties.

Economics and Land Use. Early settlers used the valleys in the blufflands for corn patches and the wooded hills for open-range hog and cattle raising. Some farms were early commercialized, and tobacco became a major cash crop. By the Civil War, agriculture was productive, thanks to easy access to the Mississippi River. Railroads and national economic forces have caused agriculture to change fundamentally in the twentieth century. Small, marginal farms merged into larger units. Cropland was abandoned in favor of pastures and an enlarged livestock economy. Hogs became more important. Fruit growing, especially apples, became locally important. Manufacturing has long been important in Hannibal, but it is weakly developed elsewhere. Commercial activity is strong in Hannibal and smaller towns. St. Charles County has become highly urbanized with a diversified economy. Land use in the subsection is primarily agricultural. The better soils and smoother lands are in crops, but by far most of the land is in pasture, both improved and wooded. On the steepest slopes of the blufflands and in the Salt River valley, large areas remain in forest. Recreational land use is scattered around Mark Twain Lake. Urban land use dominates in St. Charles County and is rapidly spreading into Lincoln and Warren Counties along highway corridors.

LANDTYPE ASSOCIATIONS

The Mississippi River Hills Subsection has been broken into landtype associations (LTAs). Five are Woodland/Forest Hills LTAs with a varying degree of surface roughness and loess influence, and one small Prairie Plain LTA occurs. The LTAs are described briefly in the following table.

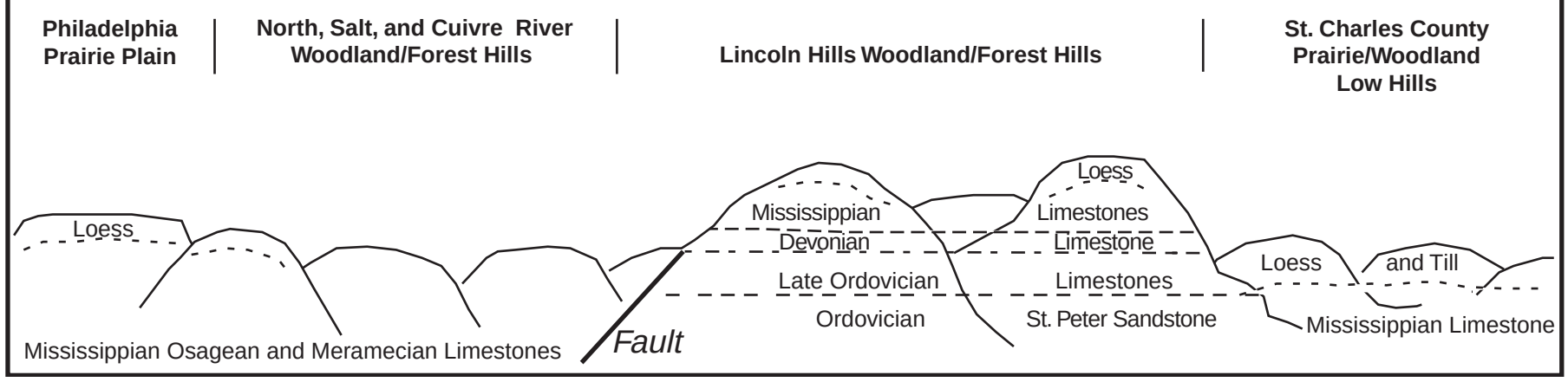
CONSERVATION CHALLENGES AND OPPORTUNITIES

Proximity to the Mississippi River has fostered human settlement in the subsection for almost two centuries. Consequently, the varied native ecosystems of the region are largely fragmented and somewhat degraded. The prairies, savannas, open woodlands, and glades characteristic of the region are largely destroyed by human activities or overgrown with invasive woody species and have a diminished ground flora diversity. Restoration with prescribed fire shows high potential for success and suggests the possibility of an enlarged grazing and timber resource. Exceptionally large blocks of forest are still associated with more rugged lands, especially in the rugged knobs area in the Lincoln Hills LTA where there is little public land. These could be focal areas for forest conservation efforts. Numerous caves occur but most are unprotected on private lands. The streams of the region have outstanding aquatic assemblages that deserve attention. The deep loess soils are highly erodible without preventive farming practices. By including natural resources in the long-term development strategy for the region many of the things that make it special could be sustained.

Prominent timbered knobs are characteristic features of the Lincoln Hills LTA.

Dawn Stegeman

LANDTYPE ASSOCIATIONS IN THE MISSISSIPPI RIVER HILLS SUBSECTION



(see landtype associations map pgs. 68–69)

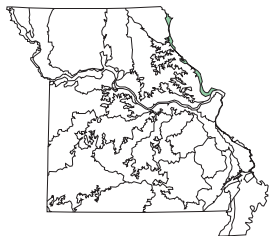
LANDTYPE ASSOCIATIONS IN THE MISSISSIPPI RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP8a Philadelphia Prairie Plain	The LTA occupies a narrow, loess-covered divide between the North and South Fabius Rivers in central Marion County. Boundaries are drawn to encompass the former prairie plain with less than 75 feet of local relief.	The small LTA consists of a flat upland with less than 75 feet of local relief. Formerly all prairie with loess-derived soils, today it is mainly cropland with scattered pasture.
TP8b North River Woodland/ Forest Hills	The LTA occupies hills associated with the North and South Rivers in Marion and Shelby Counties. Boundaries are drawn to enclose hills with local relief over 100 feet. The northern boundary with the Wyaconda Hills is drawn for convenience along the South Fabius River to separate a region with broad, parallel drainage divides. The eastern boundary is the bluff line of the Mississippi alluvial plain.	The LTA consists of broadly rolling loess- and till-covered uplands that give way to moderately steep slopes and broad valleys cut into till and cherty limestones. Local relief ranges from 100 feet on the margins to more than 200 feet along the major streams. Historically, the ridges were oak savanna and prairie that graded into oak and mixed-hardwood woodland and forest. Today, the region is mainly cool-season pasture with scattered cropland in bottoms and flat uplands. Some second-growth forest occurs in isolated patches.
TP8c Salt River Woodland/Forest Hills	The LTA occupies hills associated with the lower Salt River and its Spencer and Peno Creek tributaries. Boundaries encompass hills with over 100 feet of local relief but exclude the more rugged, loess-covered blufflands along the Mississippi River.	The LTA consists of broadly rolling loess- and till-covered uplands that give way to moderately steep slopes and broad valleys cut into till and cherty limestones. Local relief ranges from 100 feet on margins to more than 200 feet along Salt River, where rock-faced cliffs line the valley walls and some shorelines of Mark Twain Lake. Karst is prominent locally, especially in the Spencer and Peno Creeks basins. Historically, the ridges were oak savanna and prairie that graded into oak and mixed-hardwood woodland and forest. Glades were scattered on steep, exposed, rocky slopes and blufftops. Today, the region is mainly cool-season pasture with cropland concentrated in bottoms and smoother uplands. Occasional second-growth forest occurs in isolated patches. Mark Twain Lake and associated public lands are entirely within this LTA. The LTA includes several caves with rare bats, unique shale glades, and sinkhole ponds. Recreational land use is increasing around Mark Twain Lake.

(table continued on pg. 54)

LANDTYPE ASSOCIATIONS IN THE MISSISSIPPI RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP8d Lincoln Hills Woodland/ Forest Hills	The LTA occupies a long, discontinuous belt of rugged hills and knobs along the Mississippi River from just north of Hannibal in Marion County south to Winfield in southern Lincoln County. The western boundary marks the decline of local relief to less than 200 feet; it is especially sharp around Bowling Green. The eastern boundary is the bluff line of the Mississippi River alluvial plain.	The LTA consists of the most rugged hills along the Mississippi River of northern Missouri. Local relief is 200–350 feet. Where the belt is broadest in Pike County, distinct, isolated knobs, capped by Burlington limestone, are prominent landscape features. Outstanding cliffs face the river. Glacial till is virtually absent, but all ridges are moderately to deeply mantled with loess. Several Ordovician and Mississippian formations are exposed by the Lincoln Fold, and they are responsible for a geology and topography similar to that of the Outer Ozark Border Subsection, including St. Peter sandstone and Kimmswick limestone. Narrow ridges and steep slopes have cherty silt loam residual soils with bedrock outcrops. Historically, a variety of oak and mixed-hardwood woodland and forest covered the region, with scattered glades and prairie openings. Today, the region is dominated by pasture, with cropland confined mainly to bottoms, and sizeable apple orchards. Large blocks of timber occur in the roughest lands, especially in the knobs region. Glades are overgrown, although unique shale glades occur. Several limestone and sandstone cliffs support rare species. This rugged and scenic LTA has few public lands. Commercial development pressures are occurring in the Hannibal area and along major highways, and residential pressures are felt in the hills of Lincoln County.
TP8e Cuivre River Woodland/ Forest Hills	The LTA occupies rolling hills associated with the Cuivre River basin. The eastern boundary is drawn where relief increases above 200 feet in the Lincoln Hills. The irregular western boundary is drawn where local relief declines to less than 100 feet in the till plains. The southern boundary is drawn for convenience along a watershed divide to mark a transition to more deeply loess-covered lands.	The LTA consists of broad, rolling ridges of thin till and thin loess with 100 feet of local relief that give way rather abruptly to moderately steep valleys with up to 200 feet of local relief. Valleys regularly expose Mississippian limestones and their cherty residual soils. Formerly prairie and oak savannas occupied the smooth divides and graded into oak woodland and forest in rougher lands. Mixed-hardwood forests and glades were scattered on limestone slopes. Today the LTA is over half pasture and the remainder in cropland on alluvial plains and smooth uplands. Large blocks of second-growth timber remain in rougher lands, including Cuivre River State Park. Urbanization is spreading from St. Charles County into southern Lincoln County.
TP8f St. Charles County Prairie/ Woodland Low Hills	The LTA occupies low hills associated with Dardenne and Peruque Creeks in St. Charles County. The northern boundary is, in part, a watershed divide that marks the transition to hills with slightly greater relief, thinner loess, and more bedrock control of features. The rest of the northern boundary and the southeastern boundary are bluff lines. The southwestern boundary is a watershed divide to mark a change to much rougher blufflands along the Missouri River. The western boundary is placed where local relief declines to less than 100 feet in the till plains.	The LTA consists of broad, loess-covered hills in the north that become more steep-sided in the south, nearer the Missouri River. Local relief in the north is closer to 100 feet but rises to nearly 200 feet closer to the Missouri River. Natural and human-induced erosion has redeposited loess in stream valleys. Historically, prairie dominated the uplands and graded into oak savanna and woodland in the valleys. Mixed-hardwood forests occupied the deepest valleys. Today, the region is largely urbanized by growth of the St. Louis metropolitan area. I-70 traverses the LTA completely across St. Charles County. Nonurbanized lands are largely pasture with occasional cropland. Small, isolated stands of second-growth timber are common in rougher lands. The LTA includes Busch and Weldon Springs Conservation Areas.

TP9
MISSISSIPPI RIVER ALLUVIAL PLAINS SUBSECTION

(see map pgs. 68–69)



GENERAL DESCRIPTION

The subsection consists of the alluvial plain and channel of the Mississippi River adjacent to the Central Dissected Till Plains of northeastern Missouri. The alluvial plain has very deep loamy and clayey soils of variable drainage capacity. In presettlement time, the river was extensively braided, with numerous islands and backwaters. Marshes and wet prairie were common on poorly drained soils, while bottomland forest occupied the better-drained sites. Today, a series of locks and dams have drastically altered the hydrology, but the impoundments have maintained a diversity of islands, sandbars, and channels. Many islands are timbered. The main bottoms are artificially drained and in cropland, but some oxbow wetlands remain. Extensive flooding in 1993 killed much of the remnant oak-dominated forest.

LOCATION AND BOUNDARIES

This alluvial plain subsection lies in northeastern Missouri along the Mississippi River. It extends from the Des Moines River southward almost to the Missouri River in St. Charles County. It includes disconnected fragments in Clark, Lewis, Marion, Ralls, Pike, Lincoln, and St. Charles Counties. Its eastern boundary is the Mississippi River, the state boundary. Its western boundary is the bluff line that separates it from the Mississippi River Hills Subsection. In the south, where it merges with the Missouri River Alluvial Plain Subsection of the Ozarks, the boundary is marked by a pronounced alluvial terrace. The subsection extends into Illinois and Iowa.

CLIMATE

Mean annual precipitation is 38–39 inches. The wettest months are April–September, and 61 percent of the annual precipitation occurs during the six warmer months of the year (at Hannibal). Annual snowfall ranges from 24 inches in the north to 20 inches in the south. Mean January minimum daily temperature ranges from 14° in the north to 17° in the south. Mean July maximum daily temperature is 88°. The growing season averages 200–210 days. Microclimatic variations are insignificant except over and adjacent to the river surface. Fog often forms in spring and fall due to the difference between the temperatures of the water and overlying air.

TOPOGRAPHY AND GEOLOGY

The subsection in Missouri consists of the channel and alluvial plain of the Mississippi River. Bedrock is more than 50 feet below the surface and has no effect on surface features. The channel and alluvial plain were formed in late Pleistocene, Holocene, and Recent alluvium, much of it related to glaciation. The alluvial plain is silty and loamy, with relief less than 10 feet. Alluvial fans and colluvial wash mark the bluff line. A sandy alluvial terrace stands prominently above the alluvial plain in Clark County. Most of the wetlands have been drained, although extensive wetland tracts remain in St. Charles County. The alluvial plain has been mined for gravel in several places.

Jim Rathert

Decurrent false aster is a federally listed threatened species with several known occurrences in the Mississippi River Alluvial Plain Subsection of northeastern Missouri.

SOILS

Soils in this subsection are all very deep and were formed in alluvial sediments. Subsoil development is minimal in these relatively youthful soils, and textural stratification within the soil profile is common. Soil texture and drainage vary, depending on the position within the alluvial plain. Most soils are silty to clayey and are somewhat poorly to very poorly drained. Clayey soils, such as the poorly drained Carlow and Portage series, are in back swamp or slack water positions. Silty soils, such as the poorly drained Kampville series, are on natural levees. However, due to the shifting river channel, the relationships between soils and river location may not be apparent.

HYDROLOGY

The subsection contains the channel of the Mississippi River in northeastern Missouri and a few streams and drainage channels on the adjacent bottomlands. As a natural river, the Mississippi formerly shifted its channel. Its bed and bank materials are mainly glacial silts and sands. A series of low navigational dams with locks (six in this subsection) have converted the river into a series of "pools." Water elevations fluctuate, but the channel is not so morphologically dynamic as before, except in the reaches below dam spillways and locks. The pools increase the amount of water surface upstream from the dams. The river carries a moderate bed load of sands. Its suspended load is significantly less than that of the Missouri River. The natural river fell about 0.5 feet per mile in this subsection, but most of the fall is now at dams and immediately below them. Discharge is highest in April and lowest in September–October. There are few major flood-control dams in the basin above this subsection, and the discharge is poorly regulated. Average discharge at Canton is 97,000 cubic feet per second. The bottoms formerly were wet in many places, but most have been drained. Major wetlands remain in St. Charles County and near the mouth of the Salt River. Most bottoms are protected from floods by levees, but rare high-magnitude events submerge them and cause landscape changes.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The river was formerly highly braided, with numerous islands, side chutes, and backwaters. Annual flooding created a complex and shifting mosaic of bottomland forest, marshes, wet prairies, and sandbars. More than half of the bottomlands were formerly prairie. A large sand terrace in Clark County supported rare sand prairie communities.

Current. A series of dams and extensive draining and leveeing has radically altered hydrology. Most of the major bottoms are now cropland, although many of the islands are timbered in mainly riverfront species like willow, cottonwood, hackberry, and elm. Many remnant oak-dominated forests were killed by submergence in the flood of 1993. A concentration of natural marshes is associated with numerous duck clubs in St. Charles County.

Major Natural Community Types

Central Wet-Mesic Tallgrass Prairie

Central Cordgrass Wet Prairie

Freshwater Marshes

Riverine Sand Flats

Sycamore, Cottonwood–Black Willow Riverfront Forest

Southern Green Ash, Elm, Sugarberry Riverfront Forest

Pin Oak–Mixed Hardwood Wet Bottomland Forest

Rare or Restricted Natural Communities. Assemblages of aquatic life in the Mississippi River above the Missouri River were different than below the confluence, and despite the dams and other channel alterations, the aquatic communities are still different. While most wetlands have been drained and cleared, islands and wet areas support remnant communities. Quality wet prairies and marshes are rare. Much of the oak-dominated, wet bottomland forest died from the 1993 flood. A sand terrace at the northern end of the subsection supports unique sand prairie communities and associated species.

NATURAL DISTURBANCES

Flooding created a dynamic cycle of wetland destruction and creation that resulted in a diverse ecosystem. Drought and freezing also played important roles in shaping the hydrology of these systems. Agricultural activities of Indians, including the use of fire, helped shape the bottomland prairies of this landscape.

RARE OR ENDANGERED SPECIES

The Mississippi River Alluvial Plains Subsection contains more than 200 records of 68 state-listed species. A large majority of these species are fish, mussels, birds, and plants associated with the river and wetlands along it. Included are five species of federal concern: bald eagle *(Heliaeetus leucocephalus),* decurrent false aster *(Boltonia asteroides* var. *decurrens),* fat pocketbook mussel *(Potamilus capax),* Higgins eye *(Lampsilis higginsii),* and Indiana bat *(Myotis sodalis).* Six species have their occurrence in Missouri restricted to this subsection; two of them are associated with the sand prairie in Clark County.

NATURAL AREAS

The subsection includes four designated Natural Areas. Westport Island and Prairie Slough support outstanding bottomland forests. Oval Lake and Burr-Reed Slough contain marsh communities.

PUBLIC LANDS

The subsection has more than 27,000 acres of public land. The Missouri Department of Conservation manages more than 22,000 acres, including Cuivre Island, Leach, Marais Temps Clair, Shanks, and Upper Mississippi Conservation Areas. The U.S. Fish and Wildlife Service manages more than 3,000 acres at the Clarence Cannon National Wildlife Refuge. There is one state park, Wakonda State Park. Numerous conservation lands are associated with duck clubs.

HUMAN GEOGRAPHY

Demographics. The Mississippi River served as a major travel route for Indians for centuries, and they occupied the adjacent bottoms at various times. French and British used the river also as a regular travel route beginning in the late 1600s and thereafter used it in fur trading activities. Toward the end of the eighteenth century a French village, Portage des Sioux, was established in St. Charles County. Americans began using the river in the first years of the nineteenth century, but they avoided river bottoms for settlement except to establish river landings until midcentury. The rural population has generally been declining in the last half of the twentieth century. Most residences have been removed from flood-prone locations.

Economics and Land Use. Steamboats became common on the Mississippi River in the 1820s, and their numbers peaked in the 1850s and 1860s. Agricultural development of the bottoms started on higher terraces well before the Civil War, but most of the wetter bottoms were not drained until the twentieth century. The economy of the subsection is agricultural, except at a few places where river towns are located. Land is used chiefly for crops (soybeans, corn, and wheat), with a small pasture complement. Timber lines the river channel and wet places around the Mississippi River pools. Wetlands for recreation are prominent in St. Charles County. Urban pressures are great in St. Charles and southern Lincoln Counties, but urban land use has not yet become widespread on the alluvial plain.

LANDTYPE ASSOCIATIONS

The Mississippi River Alluvial Plains Subsection is subdivided into four landtype associations (LTAs). These are largely separated because of narrow floodplains on the west side of the river and their size and overall character. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Mississippi River Alluvial Plains have been severely altered by construction of six navigational dams with locks, channel engineering works, land draining, and land conversion to agriculture. Natural hydrologic processes have been greatly modified, and limited natural vegetation remains. However, management efforts are illustrating the resiliency of this ecosystem. Allowing for some conservation lands to act as flood storage during high water and emulating the natural hydrograph in river management will promote native species and ecosystems. Finding ways for river navigation, agriculture, and native ecosystems to coexist in the subsection will be key to future conservation success.

Locks and dams on the upper Mississippi River have maintained a diverse array of islands and backwater areas not seen on the channelized Missouri River.

Dawn Stegeman

(see landtype associations map pgs. 68–69)

LANDTYPE ASSOCIATIONS IN THE MISSISSIPPI RIVER ALLUVIAL PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
TP9a Alexandria Alluvial Plain	The LTA occupies the Mississippi River alluvial plains of northeastern Missouri north of Canton. Boundaries are the Iowa state line, the Mississippi River, and the bluff line.	The LTA consists of a broad, diamond-shaped alluvial plain associated with the mouths of the Des Moines and Fox Rivers. Local relief is 10–30 feet. A prominent sand terrace built during a higher stage of the Mississippi River during the late Pleistocene occurs below the mouth of the Des Moines. Outstanding marshes (Rose Pond and Goose Lake) support numerous unique species. Historically this bottom and the terrace were prairie. Timber was restricted to narrow bands along the rivers and on islands. Today the LTA is mostly drained and in cropland, but several remnants of the sand prairie support unique species, and there are several outstanding marshes. There is also an area of old braided channel with numerous wetlands along the Mississippi River.
TP9b West Quincy Alluvial Plain	The LTA occupies a separate alluvial plain associated with the mouths of the Fabius and North Rivers between LaGrange and Hannibal.	The LTA consists of an alluvial plain with low terraces and colluvial wash with a local relief less than 20 feet. Historically, more than half of the LTA was prairie, with timber confined to bands along streams and on islands. It has been mostly drained by ditches, and the former tributary channels have been abandoned or filled in. Today, the LTA is more than 90 percent cropland, but several public lands are associated with second-growth bottomland forest and wetlands unprotected by levees.
TP9c Ted Shanks Alluvial Plain	The small LTA occupies an isolated alluvial plain at the mouth of the Salt River and extending 8 miles up that river, all in Pike County.	The small LTA consists of an alluvial plain and low terraces with a local relief of 5–20 feet. Soils associated with the Salt River alluvium have coarser textures than those associated with the Mississippi River. Unlike other bottoms in this subsection, this bottomland was historically timbered in mixed-hardwood and riverfront forests. Several large prairies occurred on the Salt River plain, and marshes occurred throughout. Today, nearly the entire bottom on the Mississippi is in public ownership at the Ted Shanks and Upper Mississippi River Conservation Areas. The flood of 1993 killed most of the mixed-hardwood timber, but riverfront forests remain. The Salt River bottomlands are entirely cropped.
TP9d St. Charles/Lincoln Alluvial Plain	The LTA occupies a 60-mile-long alluvial plain from Clarksville in Pike County downstream to near the confluence with the Missouri River. It averages 3–5 miles wide. The downstream boundary in St. Charles County is drawn along a prominent terrace escarpment that separates Mississippi River alluvium (higher elevation) from Missouri River alluvium (lower elevation).	The LTA consists of an alluvial plain, numerous streams and drainage ditches on it, and the Mississippi River channel with numerous islands. Colluvial aprons and alluvial fans, created by loess and silt eroded from the bluffs, spread out on the alluvial plain. Much of the main bottom was historically wet prairie and marshes, and timber was restricted to strips along the rivers and on islands. Today, the alluvial plain has been drained in most places and converted to cropland. However, substantial bottomland forest and wetlands, as well as a variety of river habitats, exist along the river and on islands. Wetlands kept intact by recreation clubs are especially prominent in St. Charles County. This stretch of river is popular for river recreation, and there are numerous public lands and river accesses. Urbanization exerts strong development influences in St. Charles and Lincoln Counties.

Landtype Associations

TP1 Missouri River Alluvial Plain Subsection (western)

TP1 (eastern) map on pgs. 60–61; see text on pg. 25

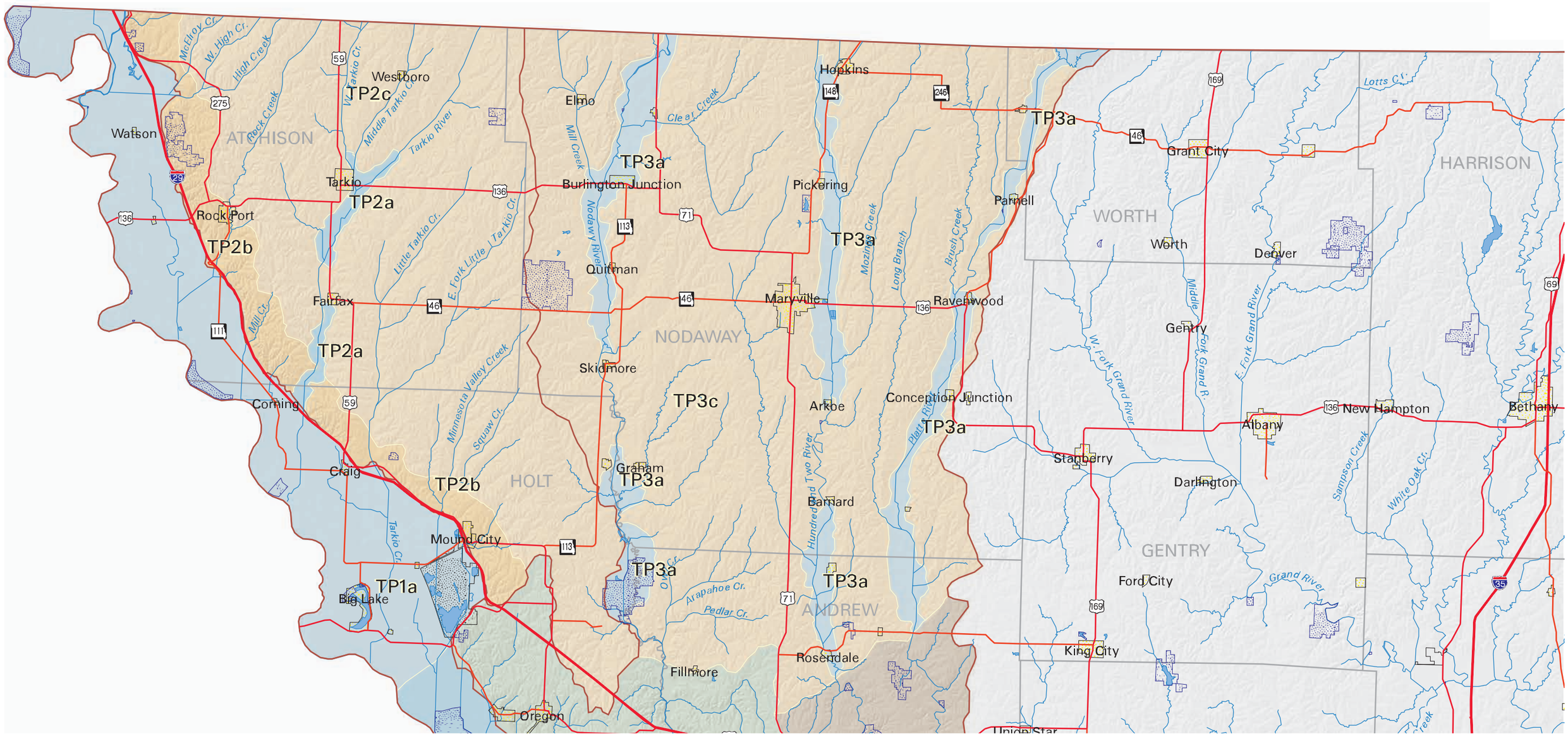
TP2 Deep Loess Hills Subsection

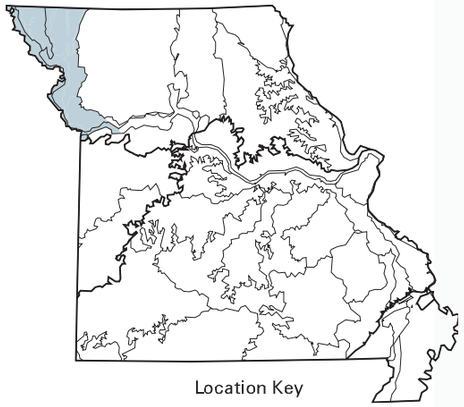
See text on pg. 28

TP3 Loess Hills Subsection (western)

TP3 (eastern) map on pgs. 60–61; see text on pg. 30

First Approximation—March 2001





Location Key

TP1 - Missouri River Alluvial Plain Subsection

TP1a Northwest Missouri River Alluvial Plain

TP1b Western Missouri River Alluvial Plain

TP2 - Deep Loess Hills Subsection

TP2a Northwest Missouri Deep Loess Alluvial Plains

TP2b Northwest Missouri Deep Loess Prairie Blufflands

TP2c Northwest Missouri Deep Loess Prairie Hills

TP3 - Loess Hills Subsection

TP3a Loess Hills Alluvial Plains

TP3b Missouri River Loess Woodland/Forest Breaks

TP3c Nodaway Loess Prairie Hills

TP3d Platte River Loess Prairie/Woodland Hills

TP3e Platte River Loess Prairie/Woodland Scarped Plain

Public Lands- Federal

Public Lands - State

County Boundaries

Ecological Subsection Boundaries

Major Roads

US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km

59

map continued on pgs. 60–63

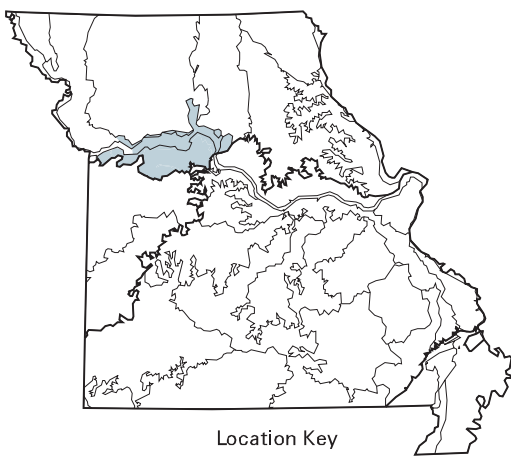
map continued on pgs. 82–83

Landtype Associations

TP1 Missouri River Alluvial Plain Subsection (eastern)
TP1 (western) map on pgs. 58–59; see text on pg. 25

TP3 Loess Hills Subsection (eastern)
TP3 (western) map on pgs. 58–59; see text on pg. 30

First Approximation—March 2001



Location Key

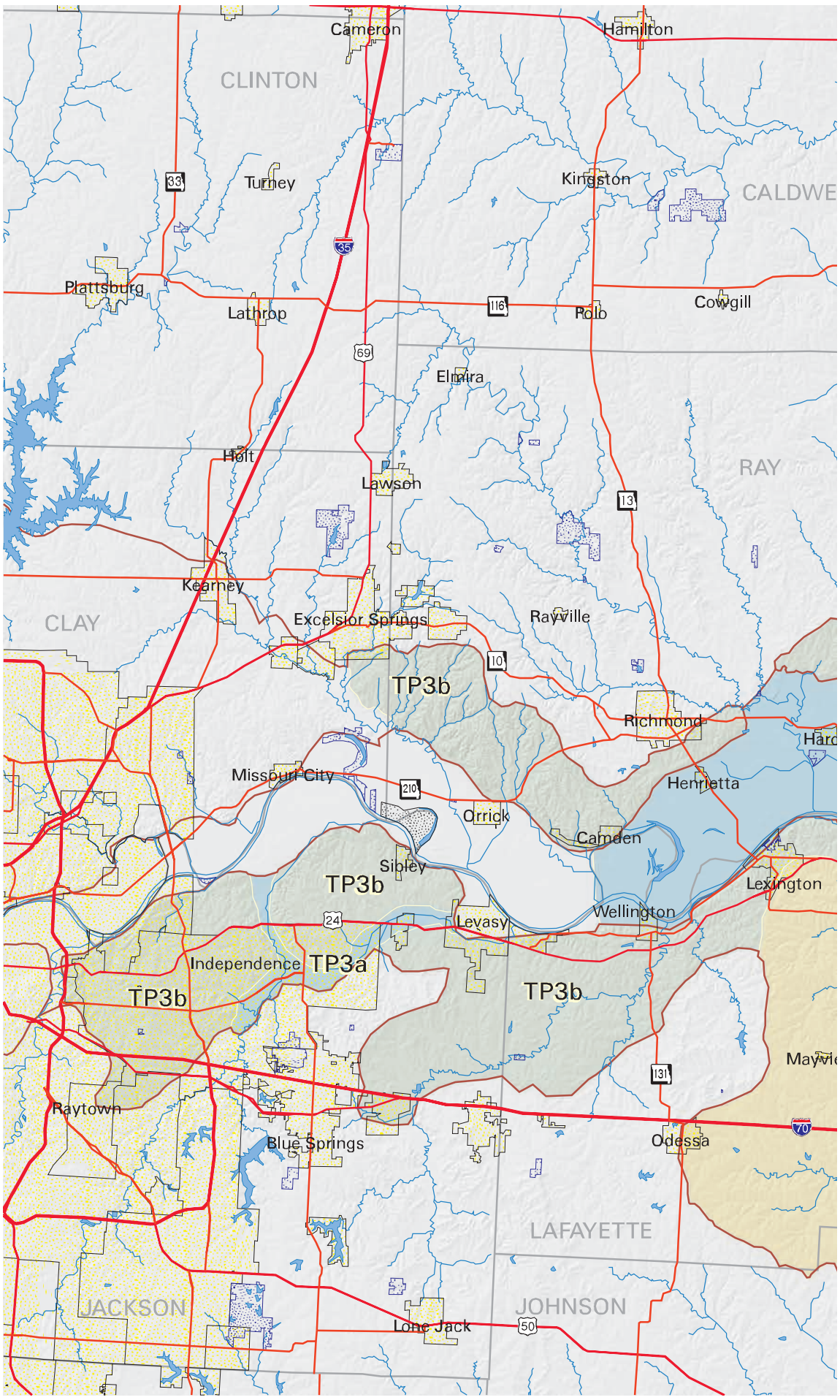
TP1 - Missouri River Alluvial Plain Subsection
TP1c Wakenda Missouri River Alluvial Plain
TP1d Missouri-Grand River Alluvial Plain
TP3 - Loess Hills Subsection
TP3a Loess Hills Alluvial Plains
TP3b Missouri River Loess Woodland/Forest Breaks
TP3f Marshall Prairie Plain

Public Lands- Federal
Public Lands - State
County Boundaries
Ecological Subsection Boundaries
Major Roads

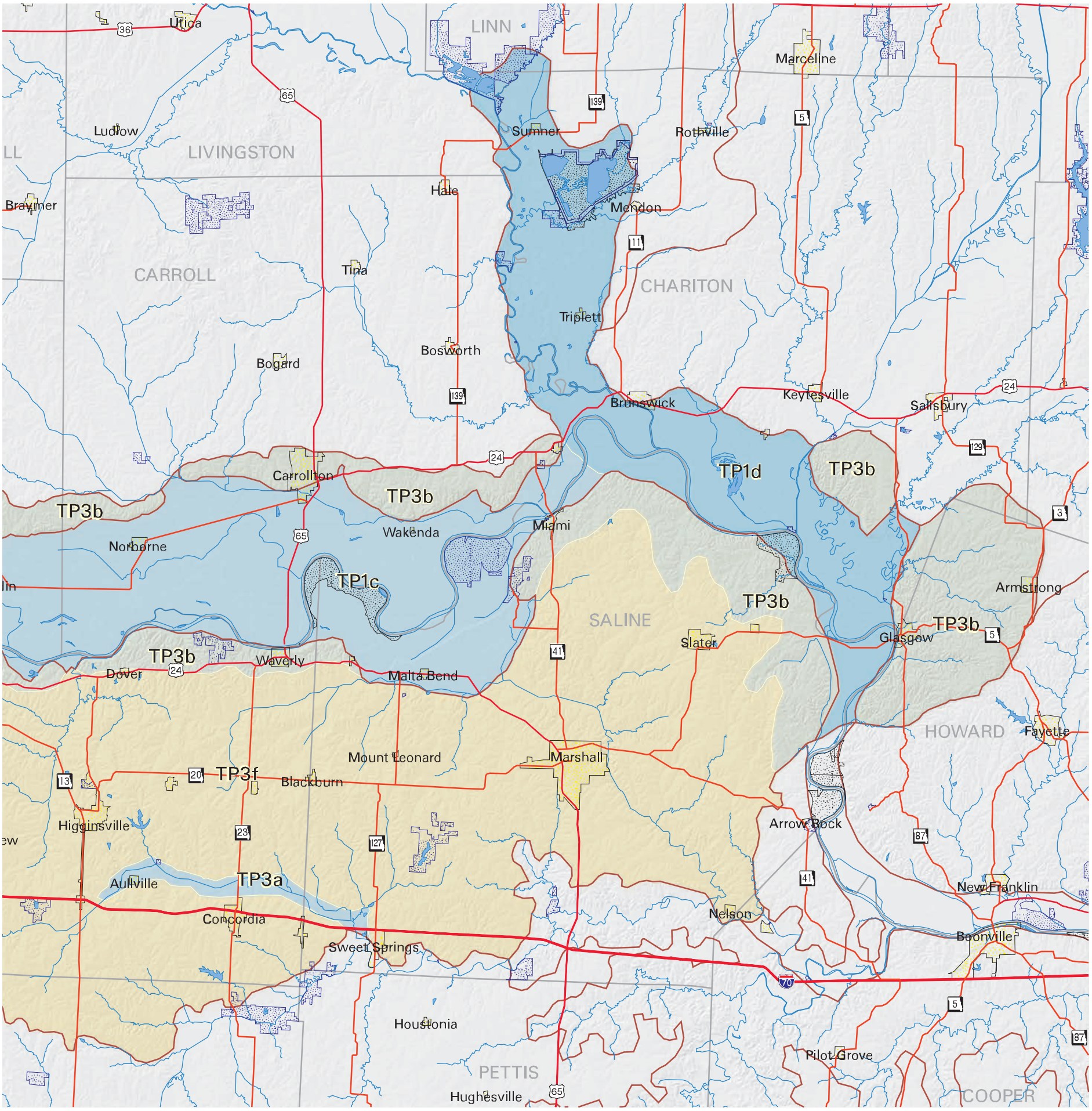
Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 mi
0 10 20 km

map continued on pgs. 58–59



map continued on pgs. 62–63



map continued on pgs. 64–65 and 174–175

map continued on pgs. 82–83 and 174–175

Landtype Associations

TP4 Grand River Hills Subsection

See text on pg. 34

First Approximation—March 2001

Location Key

- TP4a Grand River Alluvial Plains
- TP4b Upper Grand River Prairie/Woodland Hills
- TP4c Cameron Upland Prairie Plain
- TP4d Little Platte River Woodland/Forest Scarped Hills
- TP4e Crooked River Woodland/Forest Scarped Hills
- TP4f Shoal Creek Prairie/Woodland Scarped Plain
- TP4g Gilman City Upland Prairie Plain
- TP4h Trenton Woodland/Forest Scarped Hills
- TP4i Weldon River Woodland/Forest Hills
- TP4j Medicine Creek Prairie/Woodland Hills
- TP4k Lower Grand River Lowland Prairie Plains

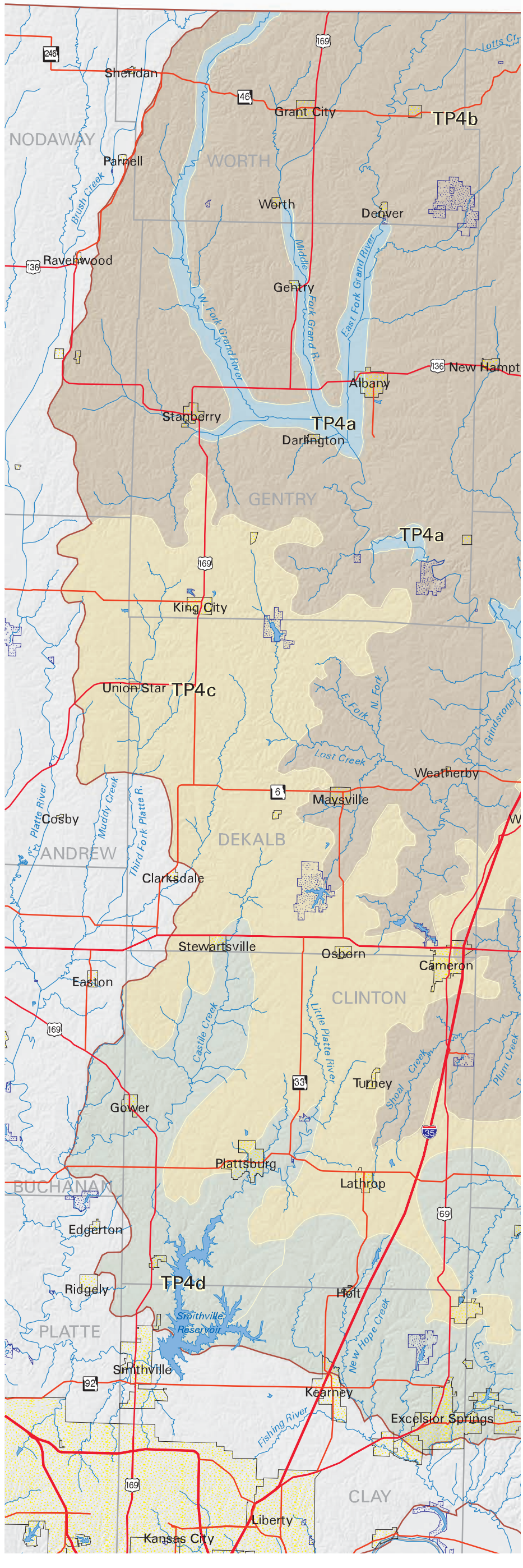
- Public Lands- Federal
- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

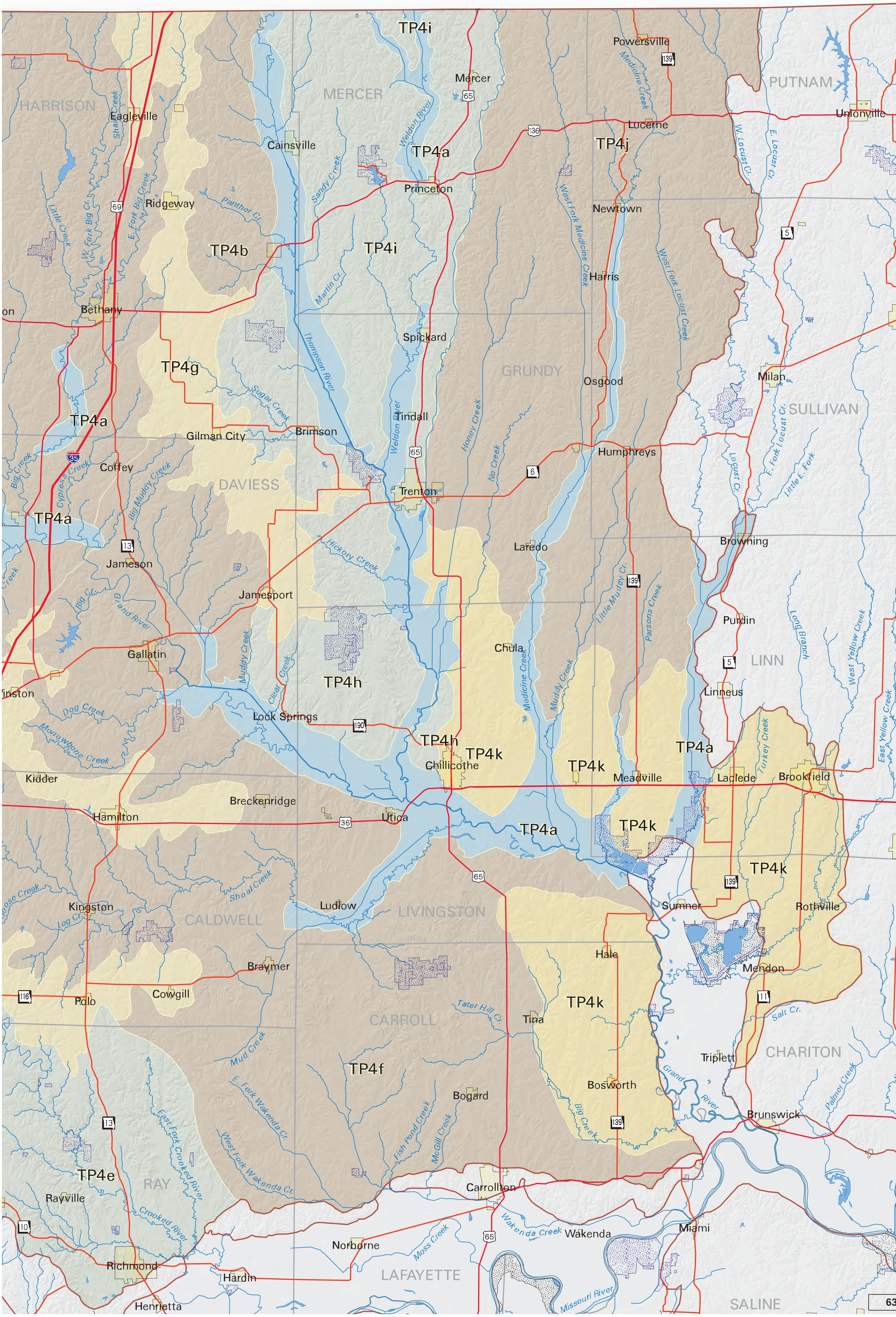
Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km

map continued on pgs. 58–59





map continued on pgs. 64–65 and 174–175

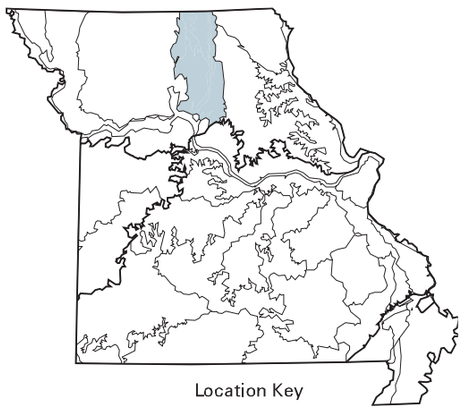
map continued on pgs. 60–61

Landtype Associations

TP5 Chariton River Hills Subsection

See text on pg. 39

First Approximation—March 2001



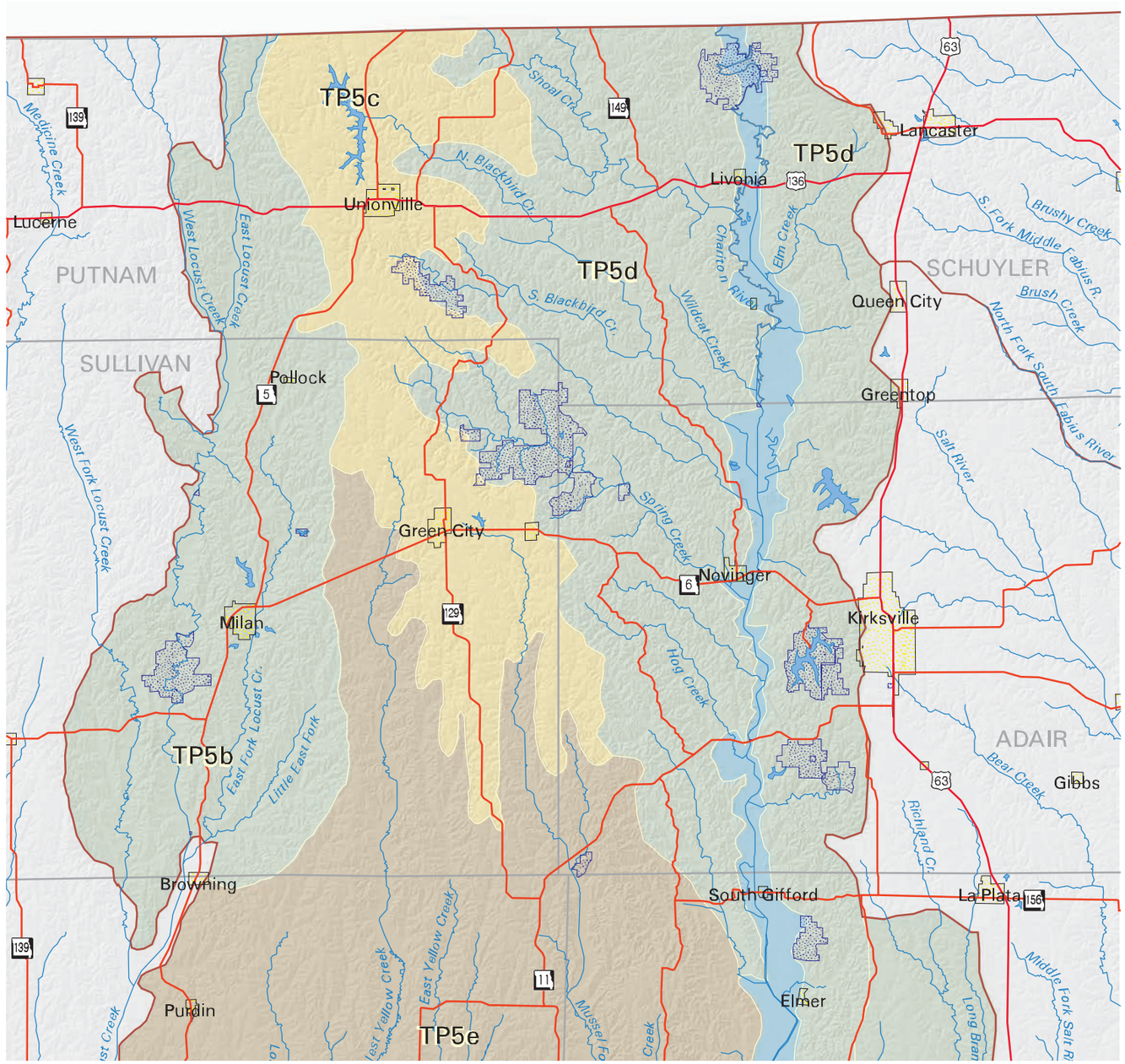
Location Key

TP5a Chariton River Alluvial Plains
TP5b Locust Creek Woodland/Forest Hills
TP5c Unionville Upland Prairie Plain
TP5d Upper Chariton River Woodland/Forest Hills
TP5e Chariton River Prairie/Woodland Hills
TP5f Lower Chariton Woodland/Forest Hills

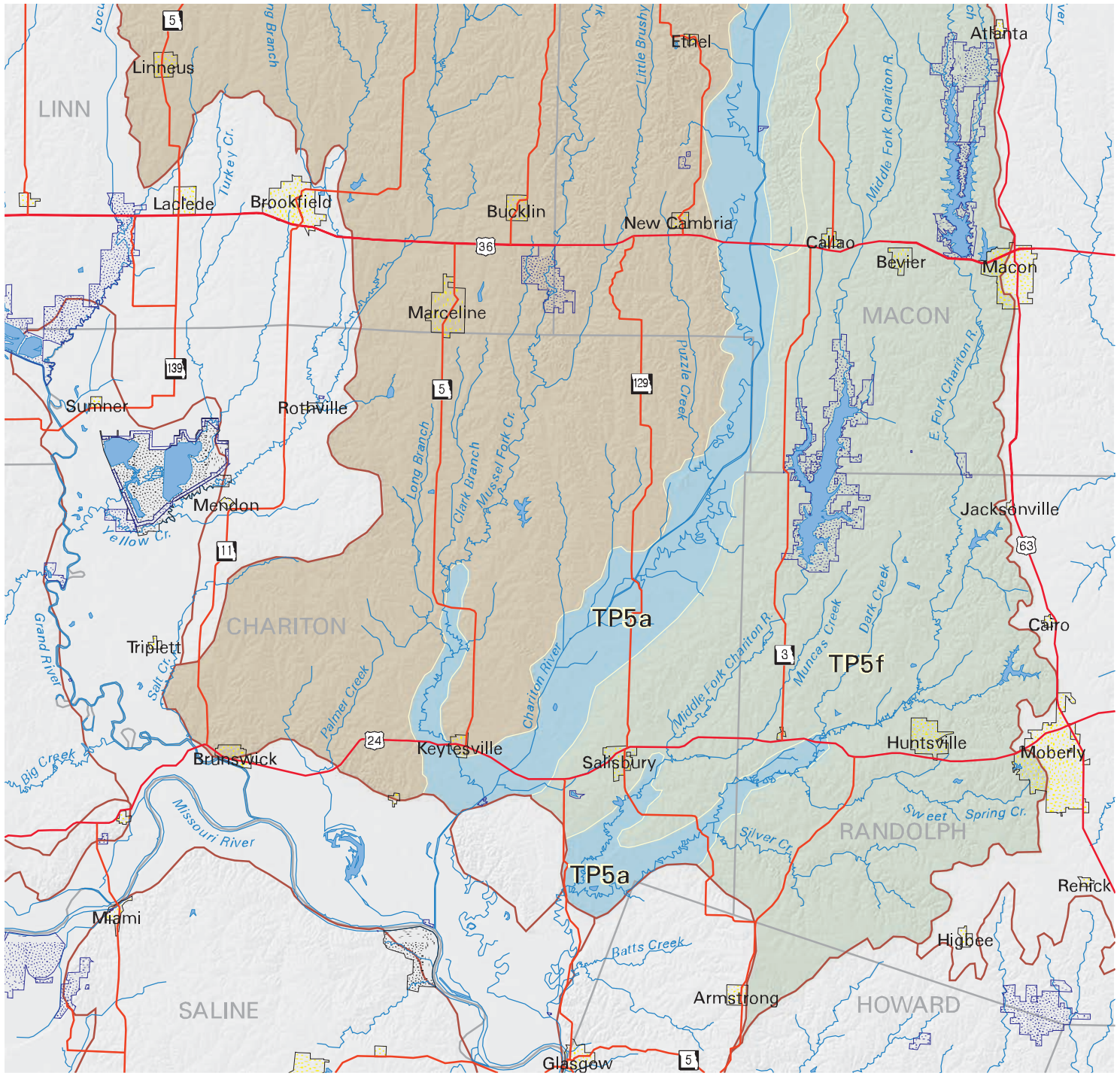
Public Lands- Federal
Public Lands - State
County Boundaries
Ecological Subsection Boundaries
Major Roads

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 mi
0 10 20 km



map continued on pgs. 62–63



map continued on pgs. 66–67 and 70

map continued on pgs. 60–61 and 174–175

Landtype Associations

TP6 Claypan Till Plains Subsection

See text on pg. 43

First Approximation—March 2001

- TP6a North Fork Salt River Alluvial Plain
- TP6b Grand Prairie Prairie Plain
- TP6c Audrain Flat Prairie Plain
- TP6d Cuivre River Prairie Plain
- TP6e North Fork Salt River Prairie Plain
- TP6f Upper Salt River Prairie/Woodland Dissected Plain
- TP6g Monroe City Flat Prairie Plain
- TP6h North Fork Salt River Prairie/Woodland Dissected Plain

- Public Lands- Federal
- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km

map continued on pgs. 64–65 and 174–175

Stoutsville
Ashburn
Mud Creek
Middle Fork Salt River
Mark Twain Lake
Florida
Paris
Center
Brush Cr.
Frankford
Cairo
Flat Creek
TP6f
Madison
Elk Fork Salt River
Spencer Creek
South Spencer Cr.
Louisiana
Huntsville
Moberly
Perry
PIKE
Clarksville
RANDOLPH
MONROE
Long Branch
Bowling Green
Rehick
Vandalia
TP6c
Higbee
Clark
Goodwater Creek
Farber
Ramsey Creek
TP6b
AUDRAIN
Laddonia
Edla
Sturgeon
Centralia
Rush Hill
LINCOLN
HOWARD
Mexico
Whiteside
Indian Creek
Silver Fork
Davis Creek
Harrisburg
Middletown
Big Lead Creek
Sllex
Hallsville
Coon Creek
Martinsburg
Wellsville
BOONE
Brush Cr.
Cave
Auxvasse
Bachelor Creek
Bellflower
West Fork Cuivre R.
Rocheport
Montgomery City
Troy
Hawk Point
Columbia
Kingdom City
TP6d
New Florence
Fulton
MONTGOMERY
Jonesburg
Warrenton
Wooldridge
COOPER
Lupus
Prairie Home
Foristell
Ashland
Jamestown
CALLAWAY
WARREN
Hermann
Hartsburg
Lake Mykee Town
Mokane
Chamois
Gasconade
Berger
MONITEAU
COLE
OSAGE
GASCONADE
FRANKLIN

map continued on pgs. 68–69

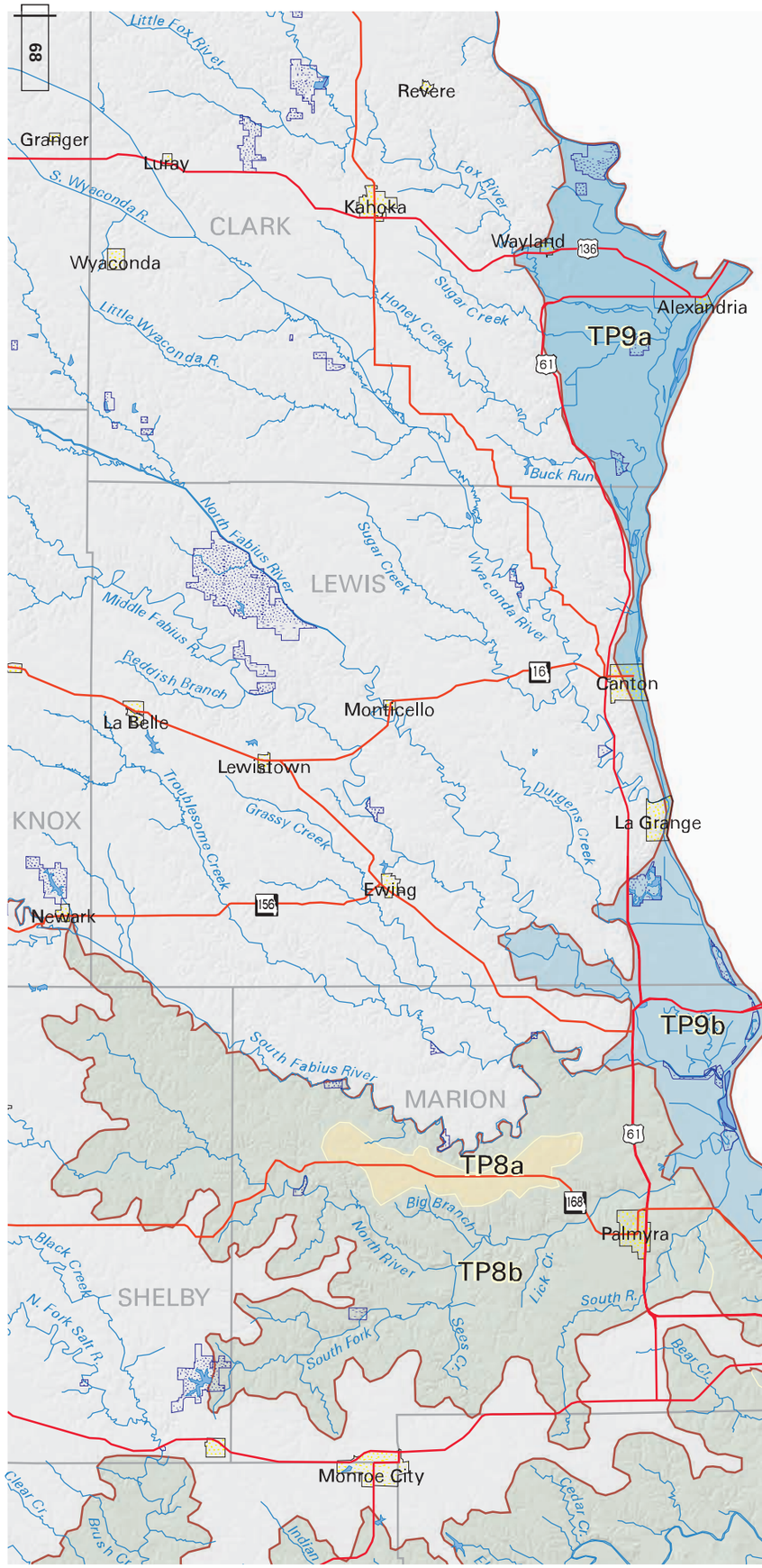
map continued on pgs. 174–175

Landtype Associations

TP8 Mississippi River Hills Subsection
See text on pg. 51

TP9 Mississippi River Alluvial Plains Subsection
See text on pg. 55

First Approximation—March 2001



TP8 - Mississippi River Hills Subsection
- TP8a Philadelphia Prairie Plain
- TP8b North River Woodland/Forest Hills
- TP8c Salt River Woodland/Forest Hills
- TP8d Lincoln Hills Woodland/Forest Hills
- TP8e Cuivre River Woodland/Forest Hills
- TP8f St. Charles County Prairie/Woodland Low Hills

TP9 - Mississippi River Alluvial Plain Subsection
- TP9a Alexandria Alluvial Plain
- TP9b West Quincy Alluvial Plain
- TP9c Ted Shanks Alluvial Plain
- TP9d St. Charles/Lincoln Alluvial Plain

- Public Lands- Federal
- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km

map continued on pgs. 66–67, 70 and 174–175

Stoutsville
Florida
Mark Twain Lake
Paris
New London
Salt River
Ashburn
Center
Brush Cr.
Frankford
Spencer Creek
S. Spencer Cr.
Peno Cr.
TP9c
TP8c
Louisiana
Perry
MONROE
RALLS
Noix Cr.
TP8d
Clarksville
Long Branch
Bowling Green
Vandalia
PIKE
Buffalo Cr.
Ramsey Creek
Youngs Creek
W. Fork Cuivre R.
Littleby Creek
Farber
Paynesville
Guinns Cr.
Laddonia
Hickory Creek
Sandy Creek
Indian Creek
Sulphur Cr.
Bryants Cr.
Elsberry
AUDRAIN
Rush Hill
Whiteside
Mexico
Davis Creek
S. Fork Salt R.
Middletown
Coon Cr.
Silex
N. Fork Cuivre R.
Little Lead Cr.
Lead Creek
TP8e
LINCOLN
Sandy Cr.
Foley
Wellsville
Brushy Fork
Winfield
Bynum Cr.
Bachelor Creek
Loutre River
Little Loutre R.
Elkhorn Cr.
Cave
Auxvasse
Bellflower
Troy
Montgomery City
Hawk Point
Bobs Creek
Bear Creek
Camp Cr.
Moscow Mills
Old Monroe
Kingdom City
Cuivre River
New Florence
MONTGOMERY
Big Creek
Indian Camp Cr.
McCoy Cr.
Peruque Cr.
TP9d
Missouri River
Fulton
Crows Fork Creek
Stinson Cr.
Jonesburg
Loutre River
Warrenton
Wright City
Wentzville
Foristell
St. Charles
O'Fallon
CALLAWAY
Bear Cr.
ST CHARLES
TP8f
Auxvasse Creek
Logan Cr.
Massas Cr.
Dardenne Cr.
Middle River
Lost Creek
WARREN
Hermann
Charrette Cr.
Callaway Fork
Femme Osage Cr.
Chesterfield
Mokane
Chamois
Gasconade
Berger
OSAGE
GASCONADE
FRANKLIN
Toque Cr.
Wolf Cr.
69

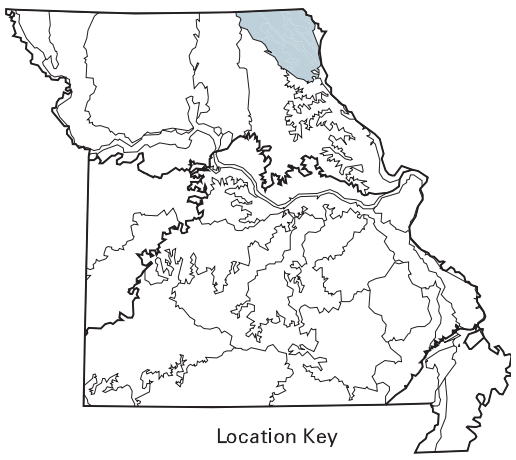
map continued on pgs. 174–175

Landtype Associations

TP7 Wyaconda River Dissected Till Plains Subsection

See text on pg. 47

First Approximation—March 2001



Location Key

- TP7a Northeast Missouri Alluvial Plains
- TP7b Lancaster Prairie/Woodland Dissected Plain
- TP7c Middle Fabius River Prairie Plains
- TP7d Wyaconda River Prairie Plains
- TP7e Fox River Prairie Plain
- TP7f Wyaconda River Prairie/Woodland Dissected Plains
- TP7g Fabius River Prairie/Woodland Dissected Plains
- TP7h Mississippi River Woodland/Forest Hills
- TP7i Fox River Prairie/Woodland Dissected Plains

- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads

Map Scale 1:411,840 (1 inch = 6.5 miles)

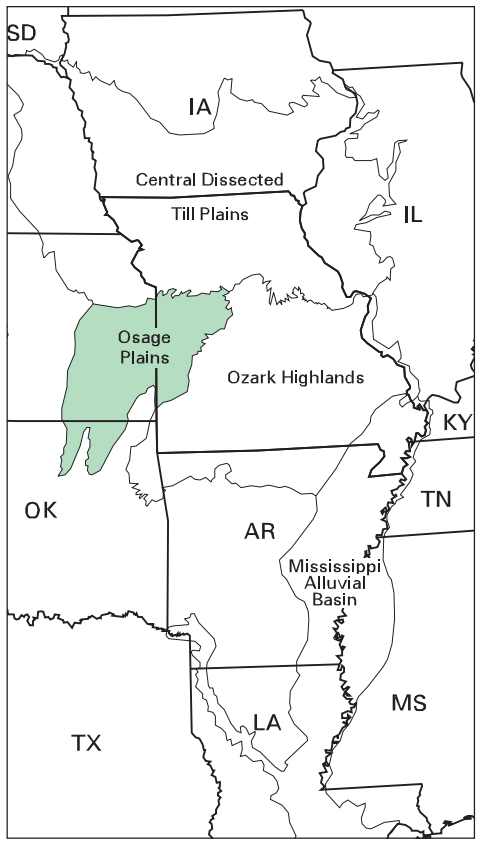
0 5 10 15 20 mi

0 10 20 30 km

map continued on pgs. 64–67

map continued on pgs. 66–69

OP OSAGE PLAINS SECTION

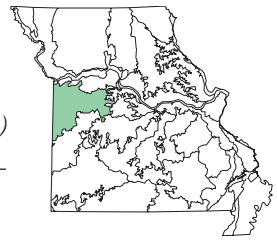


The Osage Plains Section is an unglaciated prairie plain that extends from west-central Missouri west into Kansas. A flat to gently rolling landscape underlain mainly by Pennsylvanian-age shale, sandstone, and limestone, the Osage Plains was historically nearly pure tallgrass prairie. It also contains extensive wetlands associated with streams of the upper Osage River system. Geographic differences in landform, geology, and soils produce four ecological subsections, two of which are chiefly within Missouri. The Scarped Osage Plains Subsection consists of alternating shale plains separated by limestone scarps that in a broad sense decrease in elevation in a stair-step pattern, from northwest to southeast. The flatter plains were formerly nearly continuous tallgrass prairie, while the scarped limestone areas were more dissected with bedrock outcrops and a mixture of prairie and savanna. The Cherokee Plains Subsection, lying lower in elevation, is a flat plain underlain mostly by shale, with a few sandstone areas. Also nearly pure tallgrass prairie historically, it has very broad alluvial bottomlands with extensive wetland complexes. These two subsections, as well as their landtype associations, are described in the following pages.

Jim Rathert

OP1
SCARPED OSAGE PLAINS SUBSECTION

(see map pgs. 82–83)



GENERAL DESCRIPTION

The Scarped Osage Plains Subsection is a smooth plain interrupted by low, ragged escarpments trending southwest-northeast in which limestone bedrock is regularly exposed. Local relief reaches 150 feet in the escarpment zones but elsewhere averages less than 100 feet. Valley bottoms are exceptionally broad for the size of the streams. Geologic parent materials are mainly thin-bedded Pennsylvanian limestones and shales. Presettlement vegetation was mostly prairie, with belts of scattered timber along limestone scarps and valleys. Most of the land is in farms, both pasture and cropland. The Kansas City metropolitan area exerts urbanization pressure on land use in the northwest. This subsection extends west into Kansas.

LOCATION AND BOUNDARIES

The Scarped Osage Plains Subsection occupies a large area of west-central Missouri south of the Missouri River. It includes most of Jackson, Cass, Bates, Johnson, and Pettis Counties, and smaller portions of Lafayette, Saline, Cooper, Morgan, Benton, Henry, and Vernon Counties. Two very small, disconnected tracts lie along the Kansas state line in Vernon County. The western boundary is the Kansas state line. The northern boundary is defined as a line separating loess soils to the north from residual soils derived from sedimentary rocks. This line has no expression in relief. In a very general way, the line is similar to the line generally used for the inferred southern limit of glaciation, although till occurs south of that line in small areas of Lafayette and Saline Counties. The eastern boundary with the Inner Ozark Border and Prairie Ozark Border Subsections is drawn where local relief increases to more than 150 feet. The boundary with the Osage River Hills is a very conspicuous one in the landscape and is drawn where the smooth prairie plains of this subsection break off abruptly to wooded hills with well over 150 feet of local relief. In general, the entire eastern boundary of this subsection with the Ozark Highlands Section separates this subsection's shales and thin limestones from the more resistant, thick carbonate rocks of the Ozark Highlands. The southern boundary with the Cherokee Plains is drawn, in general, along the Henrietta Escarpment, which separates two Pennsylvanian-age formations, the Cherokee Group to the southeast and the Marmaton Group to the northwest. There is a descent of 40–80 feet in elevation when passing southeastward across the line. In general, it separates a more consistently flat region (Cherokee Plains) from a more rolling region with frequent bedrock exposures (Scarped Plains). The subsection continues west into Kansas.

CLIMATE

Mean annual precipitation is 39–41 inches. The wettest months are May–June and September, and 65 percent of the annual precipitation occurs during the six warmer months of the year (at Harrisonville). Annual snowfall is 15–18 inches. Mean January minimum daily temperature is 16–19°. Mean July maximum daily temperature is 90–91°. The growing season averages 210 days. Microclimatic variations are insignificant in this subsection of very low relief.

Jim Rathert

Meade's milkweed is a federally listed endangered species whose center of distribution is in the Osage Plains Section.

TOPOGRAPHY AND GEOLOGY

The subsection lies on the northwest side of the Ozark uplift, where strata dip northwestward. This means that older Pennsylvanian formations are in the southern and eastern portions of the subsection and the younger Pennsylvanian formations on top of them are in the northwestern portions (the Kansas City area). Because the various beds of the formations are unequally resistant to erosion, the stronger beds have formed belts of low hills, or escarpments, that strike northeast-southwest, or perpendicular to the dip of the formations. The two named escarpments are the Bethany Escarpment across Cass and western Johnson Counties and the Henrietta Escarpment across northwestern Vernon, Bates, and western Henry Counties. The escarpments are ragged in outline because of stream dissection. The formations consist of alternating (cyclic) shales, thin-bedded limestones, coals, and sandstones. The limestones are the most resistant and create the escarpments. Because the limestones are thin-bedded (generally 10–20 feet thick), the ledges or clifflets where rock crops out are not high in any one place, but the effect of several is cumulative. Diagonally across Cass County, for example, the northwestward rise in surface elevation is 380 feet. Local relief in escarpment zones is 100–150 feet, but in the broader plains between them, which are dominated by shales, it falls to less than 50 feet. Residuum is relatively thin and varies according to type of sedimentary rock. A small part of the eastern end of the subsection is underlain by the cherty dolomite of the Jefferson City–Cotter Formation. The subsection was not glaciated. Coal has been strip-mined in the extreme southern parts along the Kansas border. In a few other places coal was mined historically by pits and tunnels.

SOILS

The dominant soils in this subsection were formed in loess or residuum from Pennsylvanian shale, sandstone, or limestone, with or without a thin veneer of loess. Most soils have loamy to clayey subsoils and thick dark surface layers from prairie vegetation. Depth and drainage are variable. Soils formed in loess and residuum on the broad interfluves include the Hartwell series, which are very deep, somewhat poorly drained soils with clayey subsoils. The somewhat poorly drained, very deep Macksburg soils formed in loess on interfluves in the northern part of the subsection and have silty clay loam subsoils. On lower slope positions, the very deep Sampsel series and the moderately deep Snead series are both clayey soils formed in shale residuum. Alluvial plains contain very deep soils such as the poorly drained, clayey Zook series in back swamp positions, the well-drained, silty Verdigris soils on natural levees, and the poorly drained, silty Blackoar soils in intermediate positions.

HYDROLOGY

The subsection includes major portions of the Blackwater, Muddy Creek, and the upper Lamine drainage basins; the upper portions of Big Creek and South Grand basins of the Osage River drainage basin; upper portions of the Marais des Cygnes River; and upper portions of several short tributaries directly to the Missouri River in Jackson County. Smaller streams are intermittent or ephemeral, but the larger ones are perennial although subject to discharges dwindling almost to nothing during protracted summer dry spells. Discharges are highest from April to June and decline very rapidly through the summer to their lowest from August to December. Streams carry a high suspended sediment load during periods of high runoff. Bedload is very low. Most natural channels are in silt or clay and are quite stable. Many channels have very low gradients and are extremely meandering. However, long stretches of the larger streams have been straightened by channelization. No longer in equilibrium, these drainage channels tend to be unstable with highly erodible banks and bed, which contributes to the heavy silt load. Bottomlands were formerly wetlands, but most were drained when channelization was done. Channelization has probably enhanced flooding at the end of channelized stretches. Flash floods are common on all smaller streams, and overbank floods of the larger streams occur after periods of high-intensity rain or protracted rains. Hundreds of ponds and lakes have been constructed, many for livestock and irrigation, and some larger ones for municipal water supplies, residential development, recreation, and flood control (Jackson County). Water quality can be degraded by agricultural runoff and by urban runoff in the Kansas City metropolitan area. Groundwater is saline and generally unacceptable for domestic purposes. Some natural springs are saline.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The region was formerly over 80 percent prairie, mostly tallgrass prairie. Oak savannas and woodlands occupied the steeper scarped areas and valleys. Marshes and bottomland forest were common, and saline springs frequent.

Current. Today the region is over 60 percent fescue pasture, with large fields of cropland in the flatter interscarp plains. Approximately 60 prairie remnants, most less than 100 acres in size, are in the subsection. A concentration of remnants occurs in southern Pettis and northern Benton Counties. Timbered areas are uncommon and are confined to the steepest lands often along limestone scarps; true forests are virtually nonexistent. Significant urbanization is associated with the Kansas City area.

Major Natural Community Types

Midwest Dry-Mesic Chert and Limestone Prairie

Central Post Oak Dry Barrens (Savanna)

Post Oak–Blackjack Oak/Bluestem Dry Chert Woodland

Chinquapin Oak–Ash (Eastern Red Cedar)/Bluestem Dry Limestone Woodland

White Oak–Black Oak Dry-Mesic Chert Woodland

White Oak–Mixed-Oak/Redbud Dry-Mesic Limestone Forest

Rare and Restricted Natural Communities. Presettlement prairie and savanna natural communities are rare. The limestone prairies once widespread in the region were restricted to this subsection and the Springfield Plain Subsection; only 16 remnants are known. The largest limestone woodlands in the state formerly occurred in this subsection; today few quality remnants are known. Small limestone glades were formerly associated with the woodlands. The cluster of remnant chert prairies in the eastern part of the region provides an opportunity for conservation of prairie and grassland resources at a landscape scale. Most of the saline (or mineral) springs that were formerly in the subsection and the adjacent Outer Ozark Border have been destroyed.

NATURAL DISTURBANCES

Fire and grazing by bison, elk, and deer were principally responsible for the creation and maintenance of the prairies and open woodlands indigenous to the region. Reintroduction of fire shows notable potential for restoration. Frequent flooding was responsible for creation and maintenance of diverse wetland systems.

RARE OR ENDANGERED SPECIES

The Scarped Osage Plains Subsection has more than 300 records of 53 state-listed species, a relatively high number relative to the size of the subsection. Most species are associated with prairie and grassland habitats and streams. Included are a substantial number of prairie chicken leks. Species of federal concern include Mead's milkweed *(Asclepias meadii),* western prairie fringed orchid *(Platanthera praeclara),* and Topeka shiner *(Notropis topeka).* Four species have all of their Missouri occurrences within the subsection. They are an ant *(Hypoponera opacior),* an andrenid bee *(Andrena beameri),* a beardtongue *(Penstemon cobaea* var. *cobaea),* and interior bluegrass *(Poa interior).*

NATURAL AREAS

The Scarped Osage Plains Subsection has four designated Natural Areas, all relatively small. Only one prairie, Paint Brush Prairie, contains an outstanding chert prairie. Blue River Glades is an excellent limestone glade/woodland complex. Burr Oak Woods is a limestone woodland and forest. Pin Oak Slough has a bottomland forest/wetland complex.

PUBLIC LANDS

The subsection has more than 26,000 acres of public land, the majority of which (more than 22,000 acres) is owned by the Missouri Department of Conservation. Prominent Conservation Areas include Amarugia Highlands, Burr Oak Woods, Kearn Memorial, Marshall Junction, Perry Memorial, James A. Reed, Settle's Ford, and numerous small prairies. Knob Noster State Park is also within this subsection.

HUMAN GEOGRAPHY

Demographics. The subsection constituted a significant and central portion of the Osage Indian homeland. It contained villages with cropped fields as well as extensive hunting areas. In the early 1800s Osage trading posts were established on the northern and southern sides of the subsection. Although the French had extensive contacts with the Osage nation, they did not establish permanent settlements in the subsection. Americans first penetrated the region in the 1820s along the major streams, but widespread agricultural settlement was delayed until the 1830s and 1840s because of distance from navigable rivers and the expansive prairies of the region. By the Civil War, large farms emphasizing corn and cattle were laid out, some of them employing slave labor. Settlers arriving later came from states north of the Ohio River and brought with them a greater emphasis on wheat. Kansas City and the other towns and cities attracted a variety of settlers, including a large contingent of European immigrants. German immigrants established rural communities in Pettis, Lafayette, and Saline Counties. The farm population reached a maximum in the first decade of the twentieth century and has been declining since. Some rural neighborhoods have less than half of their population of 1910. The Kansas City metropolitan area, smaller cities, and the I-70 and US 71 corridors have grown in population.

Economics and Land Use. The Civil War period was ruinous to agriculture. Counties along the Kansas line were depopulated. Untended fields reverted to brush and native animals returned. Population grew very rapidly after order was restored, railroads and wire fencing were introduced, fires suppressed, and, in general, the prairies had been made reoccupiable. Wheat, oats, corn, cattle, hogs, mules, and horses made farming profitable. In the twentieth century farm consolidation and mechanization has caused marginal farms to be incorporated into larger units and considerable land taken out of crops. Improved sorghum has increased noticeably in acreage. Cattle dominate the region's livestock industry. Agriculture remains the major economic activity and is rather equally divided between croplands on the better soils and smoother lands and pasture on the rougher lands of the escarpment belts and where soils are thin. Timber and woodland occurs in some bottoms, but most trees are scattered across the landscape or in small groves and woodlots. Manufacturing, commerce, and services are concentrated in Sedalia, Warrensburg, Harrisonville, and Butler, but the greatest economic center is the Kansas City metropolitan area of Jackson and northern Cass Counties. Urban land uses dominate in the Kansas City metropolitan area and in the smaller cities and towns. In a few localities there are relict, unreclaimed strip mines.

LANDTYPE ASSOCIATIONS

The Scarped Osage Plains Subsection is subdivided into ten landtype associations (LTAs). In addition to broad, flat alluvial plains, upland landscapes are differentiated on the degree of relief and surface roughness and corresponding soil and vegetation patterns. The LTAs are described briefly in the following table.

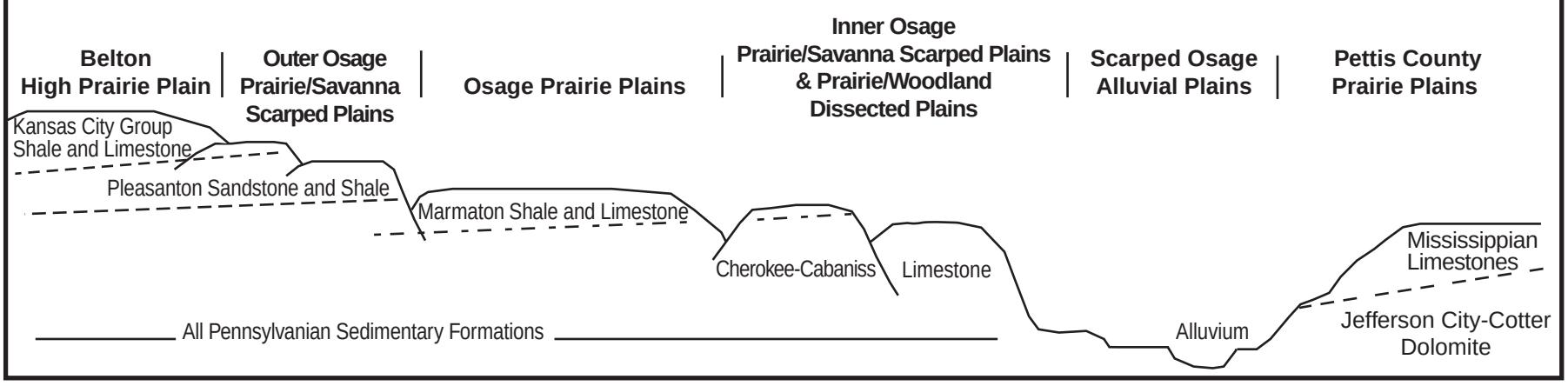
CONSERVATION CHALLENGES AND OPPORTUNITIES

Agriculture has influenced the Scarped Osage Plains Subsection everywhere. Natural vegetation is now rare and confined to isolated patches, often less than 50 acres in size. However, numerous remnants of most terrestrial ecosystems survive. More than 60 prairie remnants are known, and many are in conservation ownership. The cluster of prairies in southern Pettis and northern Benton Counties offers a major opportunity to pursue prairie and grassland ecosystem conservation at a landscape scale. Oak savanna and woodland remnants are mainly degraded, but restoration efforts with prescribed fire in the region show promise. Stream systems, though heavily impacted, offer opportunities to conserve rare fish and mussel species. Conservation activities will require private and public land partnerships to pursue ecosystem restoration on a large scale. Restoration of the native grassland/woodland mosaic will benefit not only native plant and animal species but would also provide forage and timber resources, as well as watershed protection.

Jim Rathert

Northern harriers or marsh hawks are commonly seen hunting the grasslands of the Osage Plains.

LANDTYPE ASSOCIATIONS IN THE SCARPED OSAGE PLAINS SUBSECTION



(see landtype associations map pgs. 82–83)

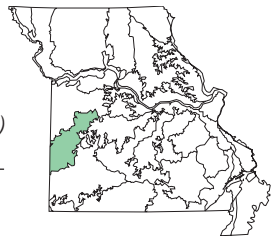
LANDTYPE ASSOCIATIONS IN THE SCARPED OSAGE PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OP1a Scarped Osage Plains Alluvial Plains	The LTA is composed of six geographically separate alluvial plains of the Blackwater River, Big Creek, South Grand River, Deepwater Creek, Marais des Cygnes River, and Little Osage River, where they are at least 1 mile wide.	The LTA consists of flat alluvial plains and infrequent terraces of the broader stream valleys. Most streams were channelized by ditching in the first third of the twentieth century, leaving abandoned, sinuous channels as remnant wetlands. Deep, finely textured alluvium forms poorly drained soils. Flooding and chronically wet soils are common. Historically, bottomland prairie, marshes, and bottomland forests dominated. Today, cropland dominates the bottomlands, but some isolated wetland complexes remain.
OP1b Jackson County Prairie/ Woodland Scarped Plain	The LTA occupies the dissected plain associated with the Blue, Little Blue, Sni-a-bar, and other short streams that drain north to the Missouri River in Jackson and southwestern Lafayette Counties. The LTA occupies the highest elevations of the Scarped Osage Plains Subsection. The western boundary is the state line. The northern and eastern boundaries mark a transition to soils derived from loess and till and to greater relief. The southern boundary is drawn generally on the drainage divide separating Missouri River tributaries from Osage River tributaries.	The LTA consists of broad, gently rolling uplands that give way to scarped limestone valleys with up to 200 feet of local relief. Limestone crops out along many valley sides. Uplands have deep, silty soils formed mainly in loess, but the soils of scarped valleys are shallow, formed from limestone and shale residuum. Historically, the LTA had prairie-covered uplands that graded into oak savanna, and then into unique woodlands dominated by chinquapin and bur oaks in the scarped areas. Some limestone glades occurred. Today, this landscape is dominated by Kansas City and Independence and by urban expansion on their southern and eastern sides. Elsewhere pasture dominates land use.
OP1c Belton High Prairie Plain	The LTA occupies two high, nearly level uplands at the headwaters of Big Creek, the South Grand, and Marais des Cygnes River. Boundaries are drawn to enclose high plains with less than 75 feet of local relief.	The LTA consists of two separate units, which are high, flat divides upheld by the youngest Pennsylvanian materials associated with the Kansas City Group. In structural terms the LTA sits on the crest of the Bethany Escarpment. Local relief is less than 75 feet. Streams are small and ephemeral. The LTA was formerly prairie on loess over residual shale soils, but today these landscapes are nearly half cropland and half pasture where not urbanized on the south side of the Kansas City metropolitan area. US 50 follows this upland plain at Lee's Summit.
OP1d Outer Osage Prairie/ Savanna Scarped Plain	The LTA occupies a scarped plain associated with the headwaters of Big Creek, South Grand River, and Marais des Cygnes River. The southern boundary is drawn at the base of the Bethany Escarpment where relief decreases to less than 75 feet. The northern boundary marks the flat summit area with relief less than 75 feet and in other places is the drainage divide with the Missouri River tributaries. The western boundary is the Kansas state line.	The LTA consists of broad, gently rolling uplands blanketed in a thin layer of loess over mainly shale residuum that give way to scarped limestone valleys with up to 150 feet of local relief. Limestone outcrops are very common and conspicuous in the open landscape. The LTA is associated with the break from Kansas City Group lithology to the lower and older Pleasanton Group, all of Pennsylvanian age. Broad divides and upper slopes were originally prairie that graded in limestone savannas and woodlands in broken lands. Today the region is primarily fescue pasture with cropland occupying smooth uplands and bottomlands. Small patches of timber occur along the streams. Urban growth is occurring at Harrisonville.

(table continued on pg. 76)

LANDTYPE ASSOCIATIONS IN THE SCARPED OSAGE PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OP1e Osage Prairie Plains	The LTA occupies four separate plains lined southwest-northeast across the middle to upper reaches of Big Creek, South Grand River, and Marais des Cygnes River. Boundaries everywhere are drawn to encompass smooth plains with less than 75 feet of local relief. The northwestern boundary is the foot of the Bethany Escarpment.	The LTA consists of flat to very gently rolling surfaces with a thin layer of loess over mostly shale and some limestone residuum, mainly on the Marmaton Group of the Pennsylvanian. Formerly nearly all tallgrass prairie, today it is a nearly even mix of cropland and fescue pasture, the former on the flattest areas. Several native prairie remnants occur.
OP1f Inner Osage Prairie/ Savanna Scarped Plains	The LTA occupies a scarped plain that extends as a continuous belt southwest-northeast across the lower to middle portions of Big Creek, South Grand River, and Marais des Cygnes Rivers. The continuity of the belt is interrupted by the wide alluvial plains of the streams mentioned. Most boundaries are drawn at a local relief of 75 feet in order to delimit this scarped plains LTA from flatter adjoining LTAs. The long southeastern boundary is the boundary of the subsection, at the base of the Henrietta Escarpment.	The LTA consists of broad, rolling uplands mainly on shale residuum that give way to scarped limestone valleys with up to 125 feet of local relief. Limestone outcrops commonly on slopes. The LTA is associated with the break from Marmaton Group lithology to the lower and older Cherokee-Cabaniss Group, all of the Pennsylvanian. Smooth divides and upper slopes were formerly prairie that graded into limestone savannas and woodlands. Today the LTA is primarily fescue pasture with cropland occupying the flattest upland and bottomland surfaces. Small patches of timber are scattered in the scarped areas. Several small native prairie remnants occur.
OP1g Upper Blackwater Prairie/ Woodland Dissected Plain	The LTA occupies a slightly dissected plain associated with the headwaters and upper reaches of the Blackwater River in Johnson County. Much of the boundary follows the Blackwater drainage divide, except where low-relief plains occur at its eastern and northern edges. In these places the boundary is drawn at 75 feet of local relief.	The LTA consists of narrow but gently rolling uplands that give way to moderate slopes and broad stream valleys mainly cut from Pennsylvanian limestones and sandstones topped with a thin layer of loess. Although local relief averages 75–150 feet, there is very little truly flat land except in valley bottoms. Prairie formerly occupied the uplands and upper valley slopes and graded into oak savanna and woodland. Today the region is primarily fescue pasture with cropland in bottoms and smoother uplands. Timber is mainly restricted to small patches on the roughest ground, except along Clear Fork and the vicinity of Knob Noster State Park, where a large block of second-growth forest occurs. Residential and commercial development at Warrensburg is expanding.
OP1h Windsor Prairie/ Savanna Dissected Plain	The LTA occupies a dissected plain associated with the headwaters of Tebo and nearby creeks along the Henry–Johnson county line. The northern boundary is generally the divide with the Blackwater and Lamine basins. The southern boundary marks the transition to low-relief plains of less than 75 feet of local relief. The western boundary marks the transition to landscapes characterized by numerous rock outcrops.	The LTA consists of a series of narrow, gently rolling divides that give way to moderate slopes with generally 100 feet of local relief. The LTA is underlain mostly by very thin-bedded sedimentaries. Prairie formerly dominated this landscape, with oak savannas confined to narrow bands along the streams. Today the region is principally fescue pasture with broad areas of cropland on the flattest divides and occasionally in the bottoms.
OP1i Northern Pettis County Prairie Plain	The LTA occupies the nearly flat, loess-covered plain of northern Pettis County. The southern boundary marks the shift to soils without any loess influence. The northern boundary marks a change to much deeper loess and is placed for convenience along the Blackwater River. The eastern and western boundaries are placed where local relief increases noticeably.	The LTA consists of a nearly flat, thinly loess-covered plain with relief less than 75 feet and in most places less than 50 feet. Formerly it was virtually all tallgrass prairie; timber was confined to narrow strips along the few streams. Today cropland makes up over 75 percent of the landscape, with the balance in fescue pasture. No prairie remnants are known.
OP1j Southern Pettis County Prairie Plain	The LTA occupies the nearly flat plain of southern Pettis and northern Benton Counties. The northern boundary is placed where loess becomes the parent material for most soils. The eastern and western boundaries mark where noticeably greater relief begins. The southwestern boundary with the Cherokee Plains Subsection is placed for convenience on a drainage divide; hardly any change is noticeable in the landscape.	The LTA consists of a large, essentially flat to gently rolling plain with a thin layer of loess. Underlying strata vary considerably and do not crop out in the LTA except along Muddy Creek west of Sedalia. The LTA's location at the junction of the Outer and Inner Ozark Borders with the Osage Plains is reflected in the complex lithology. Formerly the LTA was nearly pure prairie, including the chert prairies associated with the Jefferson City–Cotter Formation. Today the region is an even mix of cropland on flattest areas and fescue pasture elsewhere. Two clusters of remnant native prairies occur that offer landscape-scale conservation of grassland ecosystems. Urban development is occurring around Sedalia.

OP2
CHEROKEE PLAINS SUBSECTION

(see map pgs. 84–85)



GENERAL DESCRIPTION

The Cherokee Plains Subsection is one continuous plain of very low relief (usually less than 80 feet) mostly on Pennsylvanian sandstones and shales, but with associated thin-bedded limestones and coal. Streams have hardly dissected the surface, and valleys are topographically subdued. Wetlands are abundant throughout the wide, flat alluvial plains. Claypan soils add further distinction to the subsection. Presettlement vegetation was both upland and wet prairie, with timber confined to narrow strips along the stream courses. Most of the land is in farms, both pasture and cropland, with local areas of extensive strip mines. Substantial prairie remnants occur, many in conservation ownership.

LOCATION AND BOUNDARIES

This subsection lies in west-central Missouri, west of the Ozark Highlands. It comprises major portions of Henry, St. Clair, Bates, Vernon, and Barton Counties, and small portions of Pettis, Benton, Cedar, Dade, and Jasper Counties. Its northern boundary with the Scarped Osage Plains Subsection is drawn, in general, at the base of the Henrietta Escarpment, which separates two Pennsylvanian-age formations, the Cherokee Group to the southeast (which is dominated by shales) and the Marmaton Group to the northwest (which has resistant limestones). There is a slight rise of 40–80 feet in elevation as one moves northwestward into the Scarped Osage Plains. In general, this boundary separates a more consistently flat region (Cherokee Plains) from a more rolling plains with frequent bedrock exposures (Scarped Osage Plains). The northeastern boundary with the Osage Hills lies in a transitional area and is drawn where local relief along the Osage River exceeds 150 feet. The boundary with the Springfield Plain, also a boundary between two sections, is virtually impossible to discern by features in the landscape, since both subsections are smooth plains. The line is drawn where shales and sandstones and their residual soils of the Cherokee Plains give way to limestones and their residual soils of the Springfield Plain. In a general way, the line also separates a subsection associated with Mississippian-age rock (Springfield Plain) from one associated with Pennsylvanian-age rock (Cherokee Plains). The western boundary is the Kansas state line. The subsection continues a short distance into Kansas.

CLIMATE

Mean annual precipitation is 40–42 inches. The wettest months are May–June and September–October, and 64 percent of the annual precipitation occurs during the six warmer months of the year (at Nevada). Annual snowfall ranges from 18 inches in the north to 13 inches in the south. Mean January minimum daily temperature is 17–20°. Mean July maximum daily temperature is 90–91°. The growing season averages 210 days. Microclimatic variations are insignificant in this subsection of very low relief.

TOPOGRAPHY AND GEOLOGY

The subsection lies to the northwest of the Ozark uplift where strata dip gently northwestward. The plain is underlain by an alternating series of thin shales, sandstones, and coals, but shales greatly dominate. The Pennsylvanian Cherokee-Krebs Group is the dominant lithology. The shale, a rock type weak to erosion, is largely responsible for the low elevation of the subsection relative to surrounding subsections. The subsection lies lower than the Ozarks to the east and south and lower than the Scarped Osage Plains to the west. The shale is also responsible for the subsection's very low relief, which characteristically is less than 50 feet, and in many places the surface appears nearly flat. In terms of genetic geomorphology, the subsection is an "old-age" landscape that occupies a strike-valley position. Except along the eastern border with the Ozarks, stream dissection has made hardly any progress. Stream valleys are very broad and have, in many places, poor valley definition. Valley bottoms tend to be naturally wet, although many have been drained and their channels straightened by channelization. Slopes everywhere are extremely gentle and long. Locally, especially near the boundary with the Scarped Osage Plains, conspicuous mounds rise up to 150 feet above the plain. They are bedrock-cored outliers of the Henrietta Escarpment that forms the boundary. Coal has been strip-mined in numerous locations in the subsection from northeastern Henry County to Barton County in the southwest and continues to be mined in several locations.

SOILS

The dominant soils in this subsection were formed in residuum from Pennsylvanian shale, sandstone, or limestone, with or without a thin veneer of loess. Most soils have loamy to clayey subsoils and thick dark surface layers from prairie vegetation. Depth and drainage are variable. Typical soils on the broad interfluves are the Parsons series in the southwestern part and the Hartwell series in the northeastern part of the subsection. Both are very deep, somewhat poorly drained soils with clayey subsoils. Barco soils are moderately deep over sandstone and are well drained with loamy subsoils. Barden soils are very deep over shale and are moderately well drained with silty clay subsoils. Soils that are shallow over sandstone, such as Collinsville, are common on lower positions. Alluvial plains contain very deep, silty and clayey soils, such as the Osage, Lanton, and Hepler series.

HYDROLOGY

The subsection includes portions of the South Grand, Osage, Marais des Cygnes, Little Osage, and Marmaton basins in the upper reaches of the Osage River drainage basin. In the south, it also includes some headwaters of the Spring River of the Arkansas River drainage basin. Smaller streams are ephemeral and intermittent for long stretches. The major streams are perennial, but their average discharge fluctuates as much as any place in Missouri. The average June discharge of the unregulated Osage River at Osceola is seven times the average of its discharge two months later in August. High-intensity rains, especially in spring and summer, can cause severe flooding, despite the presence of large flood-control dams in the upper basin in Kansas. During summer dry spells some streams can dwindle to almost nothing. The streams virtually everywhere have silty beds and banks, are intensely meandering, and have very low gradients. Channels are naturally stable in these cohesive materials. Local channelization, however, has destroyed the channel equilibrium and caused bank erosion of the new, straightened channels. Streams carry a high suspended sediment load from channelization and during periods of major runoff. Bedload is very low. In a few places channels have shoals on limestone bedrock. Many bottoms were "overflow" lands, which were flooded annually and slow to drain. Some of these wetlands have been drained, but important remnants remain. A very large number of ponds and lakes have been constructed for livestock watering, irrigation, and municipal water supplies. The upper arms of Truman Lake extend into this subsection, chiefly along the South Grand arm. Fluctuations in the water level of Truman Lake result in large amounts of bottomland being alternately exposed as mudflats and submerged in shallow water. Water quality can be degraded by agricultural runoff, especially during periods of high runoff. Strip coal mining also may affect water quality. Finger lakes now occupy former strip mines. Groundwater is saline and generally unacceptable for domestic purposes. Some natural springs are saline (mineral) and historically served as resorts and health spas.

Tim Nigh

Prairie remnants in the Cherokee Plains Subsection are often rectangular, less than 100 acres in size, and isolated from each other.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The Cherokee Plains were formerly over 80 percent prairie. Some of the largest expanses of continuous tallgrass prairie in the state occurred here. Oak savanna occupied some valley slopes, and bottoms were in prairie, marsh, wet savanna, and bottomland forest complexes.

Current. Most of the upland surface is in fescue pasture and hay. Cropland dominates the alluvial plains and is scattered on flat upland surfaces. Timber is mainly in small, isolated patches and is usually composed of dense, invasive species. The more broken lands along Clear and Horse Creeks on the southeastern border of the subsection have some large tracts of dense, overgrown oak woodland with restoration potential. More than 24,000 acres of high-quality prairie remnants remain; some of the tracts are more than 1,000 acres in size and in conservation ownership. Clusters of native prairie occur around Liberal, Lockwood, Golden City, Taberville, and along the Marmaton River. Wetland complexes, though hydrologically altered, also occur throughout.

Major Natural Community Types

Midwest Dry-Mesic Sandstone/Shale Prairies

Hardpan Prairie

Central Post Oak Dry Barrens (Savanna)

Post Oak–Blackjack Oak/Bluestem Dry Sandstone Woodland

White Oak–Black Oak Dry-Mesic Sandstone Woodland

Central Cordgrass Wet Prairie

Rare or Restricted Natural Communities. Sandstone/shale prairies are confined to this subsection; more than 15,000 acres of remnant sandstone/shale prairie are known, many in public ownership. Hardpan (claypan) prairies are also largely confined to this subsection; only 5,000 acres are known, and few are in conservation ownership. The diverse wetland complexes were some of the best in the state; degraded remnants are common on public and private lands. High-quality streams are rare. Concentrations of extant communities have been identified for landscape-scale conservation efforts.

NATURAL DISTURBANCES

Fire and grazing by bison, elk, and deer were principally responsible for the creation and maintenance of the prairies and open woodlands indigenous to the region. Reintroduction of fire shows potential for restoration. Recurrent flooding was responsible for creation and maintenance of diverse wetland systems.

RARE OR ENDANGERED SPECIES

The Cherokee Plains Subsection contains more than 600 records of 75 state-listed species, which is a very high number. Many rare species are associated with upland prairie habitats. Many are prairie animals; the greater prairie chicken has some of its largest remaining populations in this ecoregion. A substantial number of rare species are also associated with bottomland prairie and wetland habitats. Four species of federal concern are Mead's milkweed *(Asclepias meadii),* geocarpon *(Geocarpon minimum),* gray bat *(Myotis grisescens),* and bald eagle *(Heliaeetus leucocephalus).* In addition, the only Missouri location of four species is within the Cherokee Plains. They are a sedge *(Carex microdonta),* horned rush *(Rhynchospora macrostachya),* plains harvest mouse *(Reithrodontomys montanus),* and southern prairie skink *(Eumeces septentrionalis* var. *obtusirostrus).*

NATURAL AREAS

There are 14 designated Natural Areas in the Cherokee Plains. Upland prairies are represented at Hunkah Prairie, Little Osage Prairie, Osage Prairie, Pawhuska Prairie, Regal Prairie, Taberville Prairie, Tzi-Sho Prairie, and Schell-Osage Prairie Relicts Natural Areas. Wah-Sha-She Prairie is a rare example of a flat hardpan prairie. Marmaton River Bottoms and Ripgut Prairie have outstanding bottomland prairie complexes. Dave Rock has a sandstone glade/woodland complex, and Horton Bottoms has an outstanding wetland complex. East Drywood Creek has a representative prairie stream.

PUBLIC LANDS

The subsection has more than 100,000 acres of public land. The U.S. Army Corps of Engineers owns more than 50,000 acres associated with Truman Lake. The Missouri Department of Conservation leases and manages many of the Truman lands and in addition owns over 47,000 acres of its own. Prominent Conservation Areas include Bushwacker, Buffalo Wallow Prairie, Linscomb, Shawnee Trail, Schell-Osage, Stony Point Prairie, Taberville Prairie, and Wah-kon-tah Prairie. Prairie State Park is a 3,000-acre park dedicated to prairie conservation. In addition, The Nature Conservancy owns 2,700 acres of biologically significant lands in the region.

HUMAN GEOGRAPHY

Demographics. The subsection was one of the centers of the Osage Indian homeland in the late eighteenth century. Major villages, with croplands, were located near the junction of the Little Osage and Marais des Cygnes, where the Osage River is formed. Thus, the subsection had a major imprint on the land from its Indian occupation. The French traded with the Osages but did not establish permanent settlements. The Osages moved from their villages in Missouri in the first two decades of the nineteenth century. Americans entered the region along streams to settle it in the 1830s. The people who settled the subsection came from a

Jim Rathert

Pale purple coneflower and over two hundred other flowering plants form a compact diversity of species on the many Cherokee Plains prairie remnants.

variety of eastern states. Immigration after the Civil War was even more diversified, especially those newcomers who were coal miners. Rural population reached a peak in the first decade of the twentieth century and has been declining ever since. Some rural areas have less than one-fourth of their population of 1910, and they are strongly dominated by an older-age population. Town growth has not offset the huge decline in farm population.

Economics and Land Use. Some of the best land was occupied and small farms established before the Civil War, but major farm expansion and the breaking out of large amounts of prairie into crops took place after the war. Railroads encouraged commercial farming. Wire fencing and the suppression of grassland fires encouraged the development of higher-grade cattle. Much of the native prairie land of Vernon and Barton Counties was not plowed until well into the twentieth century. Coal mining began in the late nineteenth century and stayed a major activity into the late twentieth century. Coal mining remains in Henry County and a few other places. Commerce and services are restricted to the small county seats, Nevada, Clinton, and Lamar. Manufacturing is poorly developed in this subsection. Land use is heavily agricultural. Crops (wheat, sorghum, and hay) occupy the better soils and smoother tracts, and pasture occupies the thinner and poorer soils and the tracts of more sloping land. Forests of any significant size are virtually absent, although they are more common along the eastern edge, which is transitional to the Ozarks. Scattered trees, small woodlots, and second growth on abandoned lands and strip mines are quite common. There are certainly more trees in the landscape at the end of the twentieth century than there were before American settlement.

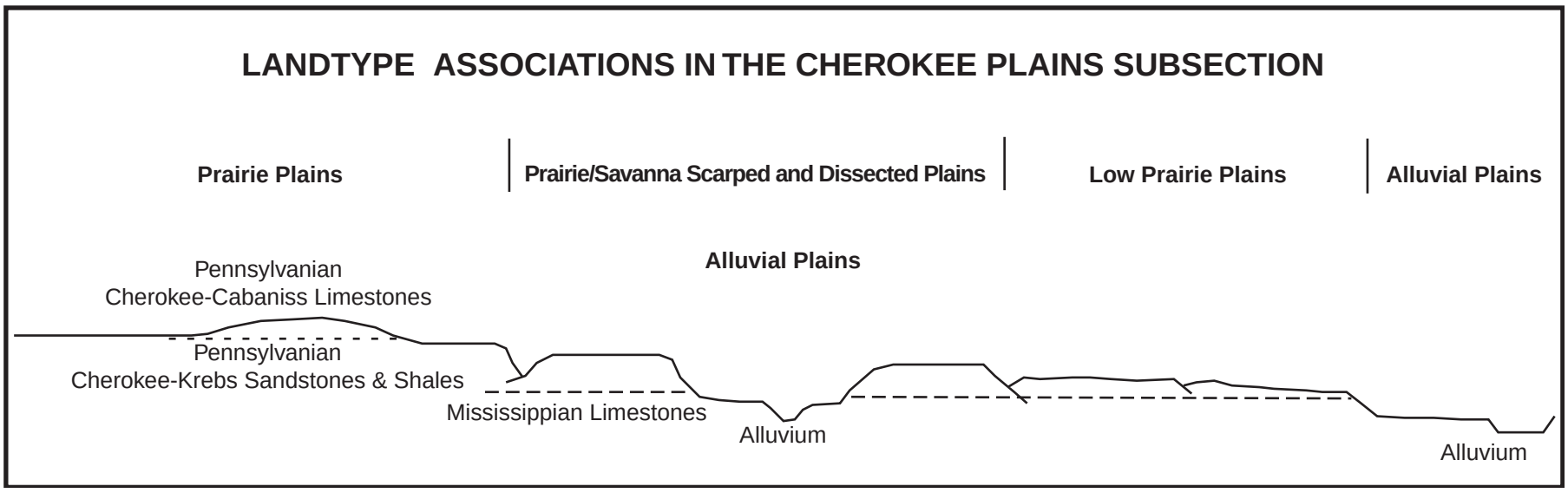
LANDTYPE ASSOCIATIONS

The Cherokee Plains Subsection has been broken into ten landtype associations (LTAs). These LTAs are differentiated mainly by the amount of relief and surface roughness and corresponding soil and vegetation patterns. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Cherokee Plains Subsection has been almost completely converted to agriculture. Natural vegetation is rare and confined to isolated patches, often less than 200 acres in size. Though native vegetation has been radically altered, numerous remnants of most terrestrial ecosystems remain. Over 175 prairie remnants are known, and many are in conservation ownership. Several clusters of prairies have been recognized and offer an excellent opportunity to pursue prairie and grassland ecosystem conservation at a landscape scale. Oak savanna and woodland remnants are mainly degraded, but restoration efforts with prescribed fire are promising. Stream systems are also degraded but offer opportunities to conserve rare species. Conservation activities will require private and public land partnerships to pursue ecosystem restoration on a large scale. Restoration of the native grassland/woodland mosaic might not only benefit native plant and animal species, but could also provide forage and timber resources and watershed protection.

LANDTYPE ASSOCIATIONS IN THE CHEROKEE PLAINS SUBSECTION



(see landtype associations map pgs. 84–85)

LANDTYPE ASSOCIATIONS IN THE CHEROKEE PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OP2a South Grand Alluvial Plains	The LTA occupies broad alluvial plains of the South Grand River and its tributaries in Henry County where they are at least 1 mile wide.	The LTA consists of flat alluvial plains and terraces with hardly any relief. In places the alluvial plains are 5 miles wide. Deep, finely textured alluvium forms poorly drained soils. Historically, bottomland prairie, marshes, and bottomland forests dominated; today, cropland dominates except for some isolated wetland complexes. Truman Lake extends into the LTA and at high pool can inundate major portions of it. As a result soils can be waterlogged for long periods, and dead standing timber occupies considerable acreages.
OP2b Four Rivers Alluvial Plains	The LTA occupies the broad alluvial plains of the upper Osage River and its tributaries, the Marais des Cygnes, Little Osage, and Marmaton Rivers, where they are at least 1 mile wide.	The LTA consists of flat alluvial plains and terraces with hardly any relief. In places the plains are 5 miles wide, but the plain nearly pinches out at the historic shoals near Schell City. Deep, finely textured alluvium forms poorly drained soils. The streams in Bates County have been channelized. Truman Lake extends into the LTA during high stages (flood pool) and significantly alters the hydrology of the rivers. Soils are waterlogged and unavailable for farming. Historically, bottomland prairie, marshes, and bottomland forests dominated; today, cropland dominates in the upper reaches unaffected by Truman Lake. Major wetland complexes remain. Large wetland conservation areas are located at Schell-Osage and Four Rivers Conservation Areas, and numerous wetlands exist on private lands. In addition, the Marmaton basin has a concentration of natural features that has been recognized for landscape-scale conservation efforts.

(table continued on pg. 80)

LANDTYPE ASSOCIATIONS IN THE CHEROKEE PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OP2c South Grand Smooth Low Prairie Plains	The LTA occupies a low, flat plain associated with the lower South Grand River and Tebo Creek basins. Boundaries are drawn to enclose an area with less than 50 feet of local relief. The southwestern boundary is drawn along a topographically inconspicuous drainage line. Clinton is in the center of this LTA.	The LTA is a low, flat, basin-like area surrounded by higher elevations. Local relief is less than 50 feet and in places is essentially flat. Formerly the LTA was more than 90 percent prairie with thin belts of timber and wetlands lining the major streams. Today the landscape is dominated by fescue pasture and hay meadows with cropland scattered throughout. Small prairie remnants are common. Public lands associated with Truman Lake extend into the LTA.
OP2d Four Rivers Low Prairie Plains	The LTA consists of four separate tracts of a low, flat plain associated with the Osage River and its three tributaries, the Marais des Cygnes, Little Osage, and Marmaton Rivers. The northern boundary is the base of the Henrietta Escarpment and is a change to higher relief. Other boundaries are drawn to enclose an area with less than 50 feet of local relief, excluding the broad alluvial plains of the four rivers.	The LTA is a low, flat, basinlike area with less than 50 feet of local relief that in most places grades imperceptibly onto the broad alluvial plains within it. Soils have a notable claypan. Formerly it was more than 90 percent prairie with thin belts of timber lining the small watercourses. Today the LTA is dominated by fescue pasture and hay with cropland scattered throughout. Prairie remnants, some more than 1,000 acres in size, are common, although public lands are not common.
OP2e Dry Wood Creek Prairie Plain	The LTA occupies a plain associated with the Dry Wood Creek in western Vernon and Barton Counties. In general, boundaries are drawn to enclose an area with local relief less than 75 feet, excluding the flat alluvial plain of the Marmaton River. The southern boundary is drawn for convenience along the drainage divide between the Osage and Neosho River basins. The western boundary is the Kansas state line.	The LTA is a flat to gently rolling plain with 50–75 feet of local relief and lies slightly higher in elevation than the low, basinlike plains to the northeast. Several very low mounds, outliers of the escarpment to the west, rise slightly above the general surface at Moundville. The LTA was formerly almost completely in native prairie with only very narrow belts of timber along drainageways. Today it is mainly fescue pasture and hay. Numerous prairie remnants, including Prairie State Park, are located here, which cause much of this and the LTA to the south to be recognized for landscape-scale prairie and grassland ecosystem restoration. Abandoned strip coal mines occur in several places.
OP2f Little Dry Wood Creek Prairie/ Savanna Dissected Plain	The LTA occupies the dissected plain along Little Dry Wood Creek in Vernon and northern Barton Counties. Boundaries are drawn to encompass slightly dissected lands with 75–150 feet of local relief.	The LTA consists of broad, flat prairie divides that give way to gentle slopes and broad alluvial plains. Local relief is 75–150 feet, with bedrock outcrops on some slopes. Historically the LTA was prairie on ridges and upper slopes that graded into oak savanna and woodland. Today this landscape is largely fescue pasture and hay meadow with small isolated patches of timber, mainly of invasive species, scattered throughout. Few prairie remnants remain.
OP2g Milo Smooth Prairie Plain	The LTA occupies the flat upland divide between Little Dry Wood and Clear Creek valleys, mostly in Vernon County. The eastern and western boundaries mark a change to higher relief. The northern boundary marks a transition to a lower-lying plain, and the southern boundary marks a transition to a broad, flat plain.	The LTA consists of a flat upland prairie plain with local relief less than 50 feet. A few mounds rise above the general surface. Soils are clays and silts with a distinct claypan. The LTA formerly was pure tallgrass prairie. Today it is mostly pasture and hay meadow with scattered cropland. Several substantial prairie remnants are clustered near the southern boundary.
OP2h Clear Creek Prairie/ Savanna Dissected Plain	The LTA occupies a moderately dissected plain associated with Clear and Horse Creek drainage basins. Boundaries encompass dissected lands with 75–150 feet of local relief. The eastern boundary marks a change to higher relief along the Sac River, and the western boundary marks a change to lower relief of upland prairie plains.	The LTA consists of broad, flat prairie divides that give way to gentle and moderate slopes into broad alluvial plains. Local relief is 75–150 feet and is the highest of the Cherokee Plains Subsection. Bedrock outcrops on the sides of some valleys. Historically, prairie on upland divides and upper slopes graded into oak savanna and woodland. Alluvial plains had wetlands. Today, this landscape is largely fescue pasture and hay meadow, with substantial patches of timber, often of invasive species, scattered on the roughest lands. Two clusters of prairie remnants occur, one in the north near Eldorado Springs and the other in the south between Jerico Springs and Lockwood.
OP2i Lamar Smooth Prairie Plain	The LTA occupies the very broad, flat plain encompassing the northern tributaries to the Spring River and the flat interfluve that separates the Spring and Osage River basins. The northern boundary encloses the plain with less than 50 feet of local relief. The southern boundary is the subsection boundary with the Springfield Plain and is marked in the landscape by a slight decline in elevation (scarp). Lamar is in the center of the LTA.	The LTA consists of a flat upland plain, very slightly dissected on the southern margins, with a local relief less than 50 feet. Streams are in very shallow valleys. Claypan soils are characteristic. Formerly more than 95 percent prairie with timber only along draws and streams, today it is mainly fescue pasture and hay meadows, with scattered cropland. Several prairie remnants occur.

LANDTYPE ASSOCIATIONS IN THE CHEROKEE PLAINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OP2j Blue Mound Prairie/ Savanna Scarped Plain	The LTA occupies a small area of prominent mounds in northeastern Vernon County, south of the confluence of the rivers that form the Osage River and southeast of Four Rivers Conservation Area. Boundaries are drawn to enclose the cluster of mounds.	The LTA consists of a tract of isolated mounds that rise up to 200 feet above the surrounding surface. Mesalike, they are capped by resistant Pennsylvanian limestones with slopes on shale and are erosional outliers of the escarpment to the northwest across the Osage River. Some have lost their limestone caps and appear as lower, rounded knobs. Historically prairie with trees on the north and east slopes of the mounds, the LTA today is primarily fescue pasture and hay meadow. No remnant natural communities are known.

Landtype Associations

OP1 Scarped Osage Plains Subsection

See text on pg. 73

First Approximation—March 2001

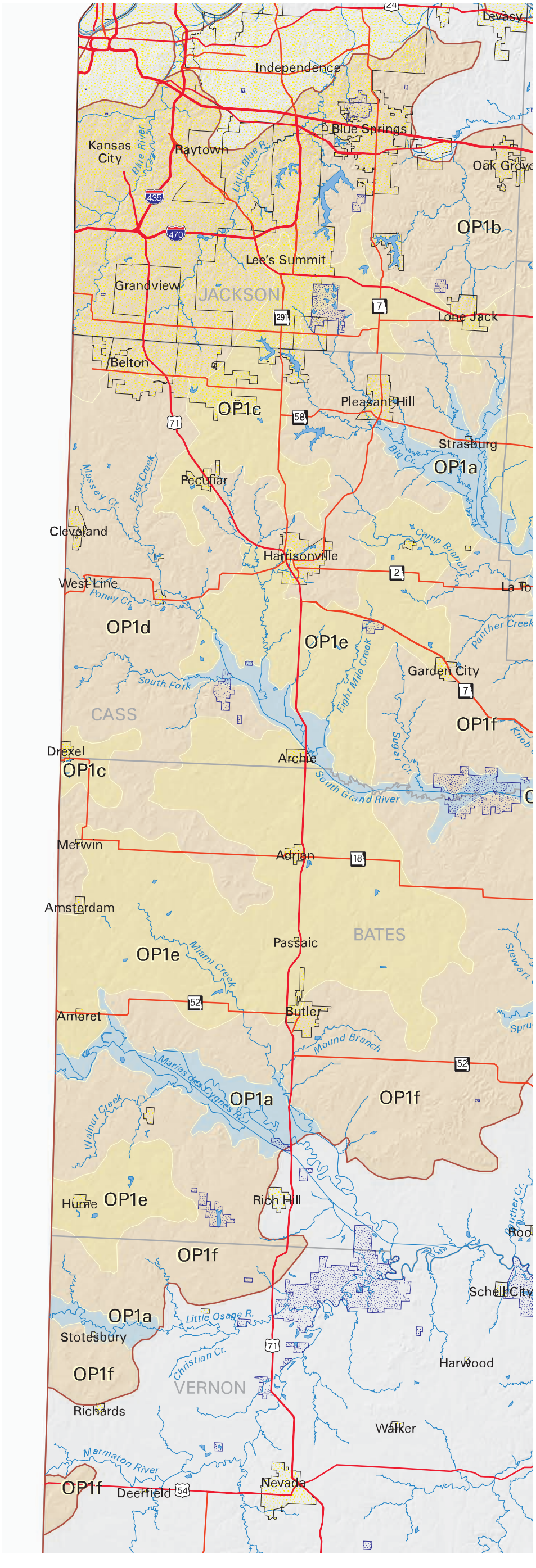
- OP1a Scarped Osage Plains Alluvial Plains
- OP1b Jackson County Prairie/Woodland Scarped Plain
- OP1c Belton High Prairie Plain
- OP1d Outer Osage Prairie/Savanna Scarped Plain
- OP1e Osage Prairie Plains
- OP1f Inner Osage Prairie/Savanna Scarped Plain
- OP1g Upper Blackwater Prairie/Woodland Dissected Plain
- OP1h Windsor Prairie/Savanna Dissected Plain
- OP1i Northern Pettis County Prairie Plain
- OP1j Southern Pettis County Prairie Plain

- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads

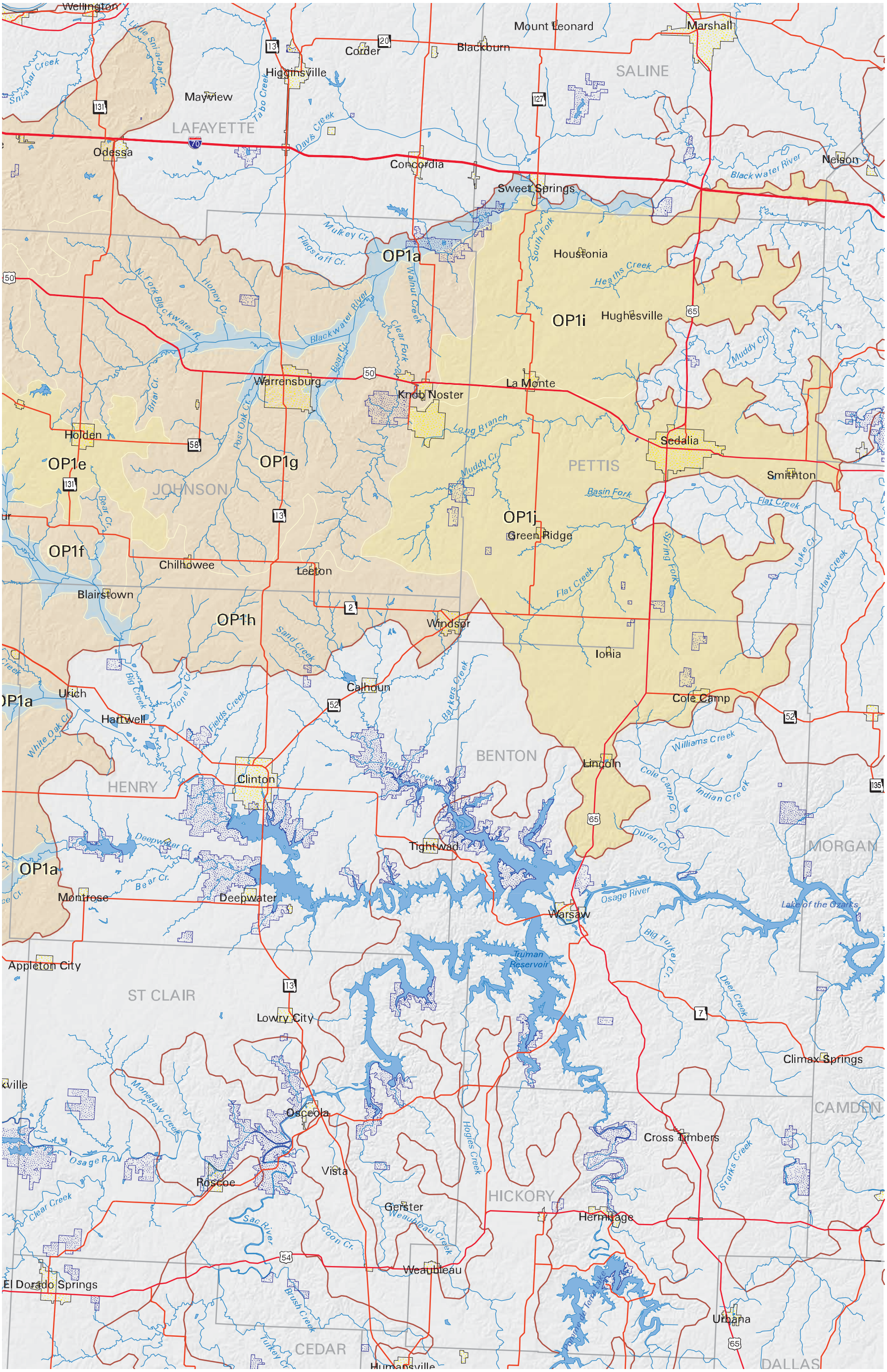
Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km



map continued on pgs. 60–61



map continued on pgs. 174–175

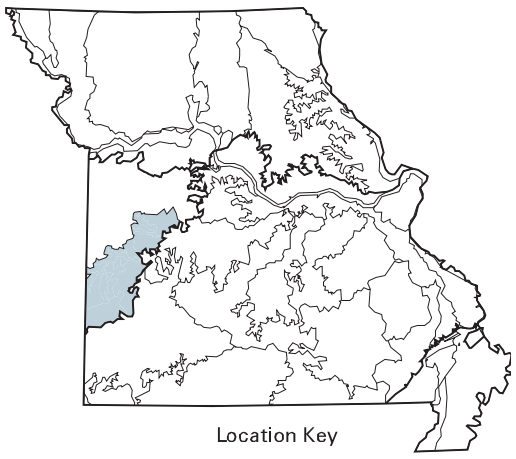
map continued on pgs. 84–85

Landtype Associations

OP2 Cherokee Plains Subsection

See text on pg. 77

First Approximation—March 2001



Location Key

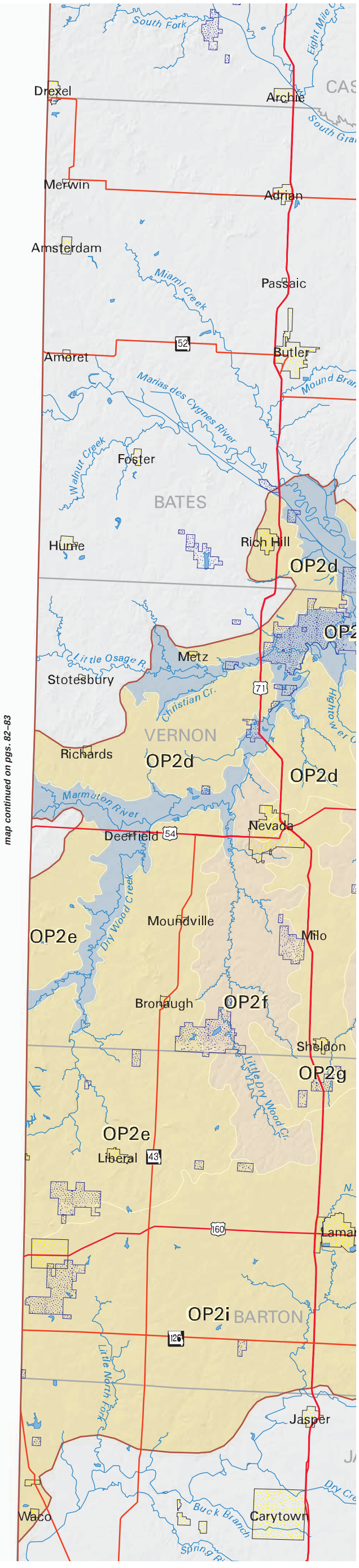
- OP2a South Grand Alluvial Plains
- OP2b Four Rivers Alluvial Plains
- OP2c South Grand Smooth Low Prairie Plains
- OP2d Four Rivers Low Prairie Plains
- OP2e Dry Wood Creek Prairie Plain
- OP2f Little Dry Wood Creek Prairie/Savanna Dissected Plain
- OP2g Milo Smooth Prairie Plain
- OP2h Clear Creek Prairie/Savanna Dissected Plain
- OP2i Lamar Smooth Prairie Plain
- OP2j Blue Mound Prairie/Savanna Scarped Plain

- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads

Map Scale 1:411,840 (1 inch = 6.5 miles)

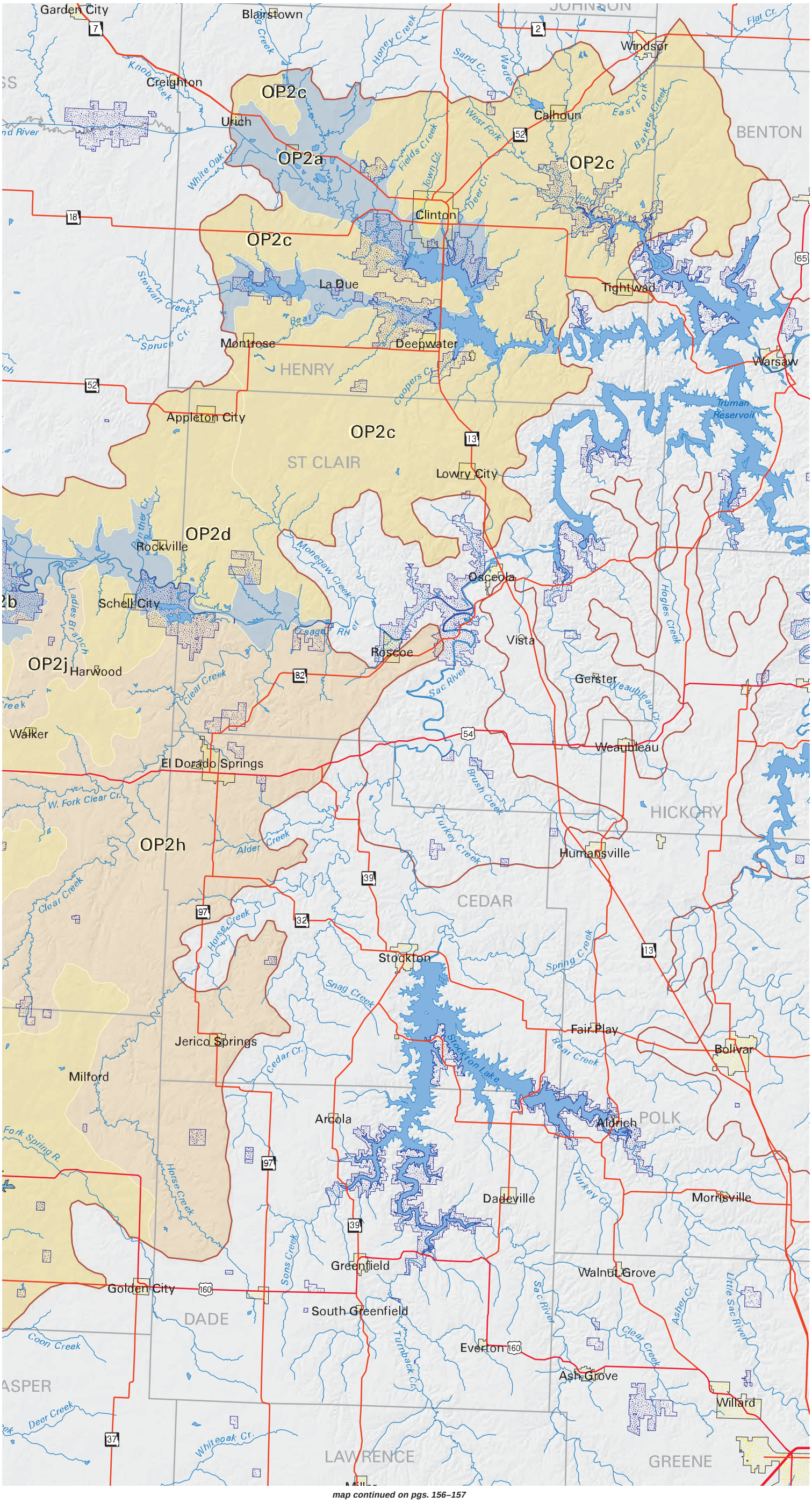
0 5 10 15 20 mi

0 10 20 30 km



map continued on pgs. 82–83

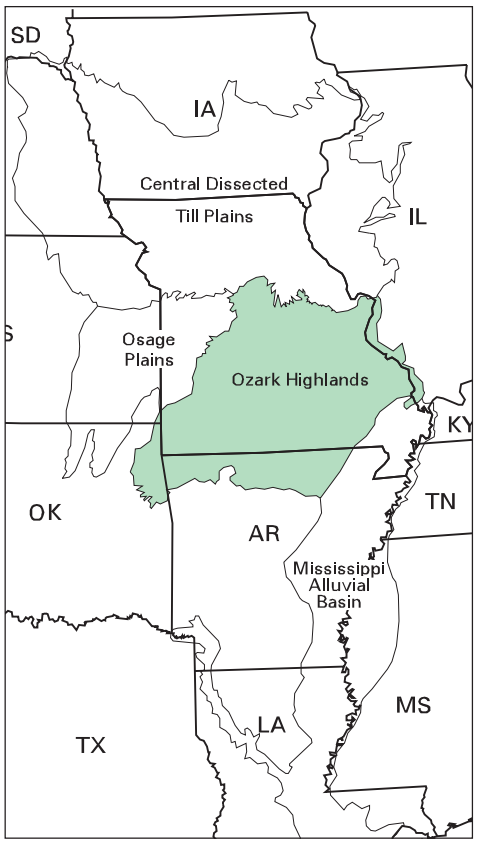
map continued on pgs. 82–83



map continued on pgs. 156–157 and 166–167

map continued on pgs. 156–157

OZ OZARK HIGHLANDS SECTION



The Ozark Highlands is a distinctive biogeographic region that includes most of southern Missouri and much of northern Arkansas and small parts of Illinois, Oklahoma, and Kansas. Geologically, the Ozark Highlands is a low structural dome of essentially horizontally bedded strata that has been undergoing erosion and weathering for a quarter billion years into a thoroughly dissected plateau. The exceptional length of geologic erosion, one of the longest in the United States, coupled with a central geographic location in North America and tremendous physiographic diversity, has created a region of unique ecosystems. Over two hundred endemic species are present.

Millennia of fluvial erosion, transport, deposition, and subterranean dissolution of carbonate bedrock have created a diversity of landforms that vary geographically in degree of relief, dissection, and parent materials and in soil and natural vegetation patterns. Throughout the Ozarks carbonate bedrock dominates, and karst features and other evidence of long-standing and pervasive rock solution characterize the entire region. The highest and least dissected parts of the Ozarks are maintained as flat to gently rolling plains that have very deep accumulations of limestone, dolomite, and chert residuum from which the soils have formed. These relatively droughty upland plains formerly supported prairies, savannas, and open woodlands. The plains give way to rolling hills closer to drainages, and then to the rugged, highly dissected hills and breaks flanking major streams that geographically dominate the section. The streams cut through a variety of geologic formations, creating multifarious landform, soil, and vegetation patterns. Residual soils in the hills are deep, rocky, and highly weathered, and they formerly supported oak and oak-pine woodlands and forest. Areas of shallow soils and bedrock exposure are common, but they vary in landscape position and extent. Rare and unique species are associated with the shallow-soil glades of the region. The streams of the Ozark Highlands are an outstanding and treasured resource. Most are spring-fed and carry very little suspended material. They occupy narrow, sinuous, entrenched valleys. Because the region is karstic, many stream channels and valleys lose water to subterranean passageways, while others receive waters by seepage and springs, sometimes from areas far beyond their surface watershed. Many unique species are associated with Ozark streams, springs, caves, fens, and cliffs.

Tim Nigh

Differences in landform, lithology, soils, and vegetation produce sixteen ecological subsections in the Ozarks, all of which occur in Missouri. The subsections include high, slightly dissected plains like the Springfield Plain and Central Plateau; rugged hills associated with the major drainage basins (Osage, Gasconade, Meramec, Elk, White, Current, Black, and St. Francis); igneous knobs and sedimentary basins of the St. Francois region; and loess-capped bluffs, karst plains, and dissected hills of the Missouri and Mississippi River borders of the Ozarks. Each subsection has a distinctive set of attributes, giving it a particular set of conservation challenges and opportunities. The subsections are further subdivided into landtype associations or ecological landscapes based on local variations in the biophysical pattern. The subsections and landtype associations of the Ozark Highlands are described in the following pages.

OZ1
SPRINGFIELD PLAIN SUBSECTION

(see map pg. 156–157)

GENERAL DESCRIPTION

The Springfield Plain is a large smooth plain in the southwestern Missouri Ozarks. Relief is generally less than 150 feet, which is accounted for by slight dissection along streams. The plain is underlain by Mississippian cherty limestones that are responsible for several areas of well-developed karst and numerous springs. Presettlement vegetation was mostly prairie, with timber along stream courses and in the more dissected border regions. Most of the subsection is cleared land, with pasture dominating, but forests occur in hillier portions. Urbanization pressures are great in the Springfield metropolitan area and at Joplin.

LOCATION AND BOUNDARIES

The Springfield Plain lies in the western Ozark Highlands of southwestern Missouri. It comprises the major portions of Cedar, Dade, Jasper, Newton, Lawrence, and Greene Counties, almost half of Polk, Webster, Christian, and Barry Counties, and minor portions of St. Clair, Hickory, Barton, McDonald, Stone, and Douglas Counties. Its northeastern boundary from northern Hickory County to Webster County and its southeastern boundary from Webster County to southern Barry County are defined as the visibly conspicuous Burlington Escarpment. This escarpment is both an elevational change from the higher Springfield Plain to the lower adjacent subsections (and thus justifies the term *plateau* for the Springfield Plain in these areas) and a lithologic change from Mississippian cherty limestones of the Springfield Plain to other, older carbonate rocks in adjacent sections. The escarpment in Polk County is ragged and marked by numerous breaks and isolated outliers, which makes drawing a single boundary line difficult. The southern boundary, from Webster County to the Oklahoma state line, is a major topographic break between the much smoother Springfield Plain and deeply dissected land in adjacent subsections. The line is drawn at approximately 150 feet of local relief. This boundary is especially sharp in Douglas, Christian, and McDonald Counties, although it is extremely irregular. The southwestern boundary is the state line with Kansas and Oklahoma. The northwestern boundary is also the boundary between the Ozark Highlands Section and the Osage Plains Section. Although a sectional boundary, it is virtually impossible to discern readily by landscape relief. It is drawn where the limestones and their residual soils of the Springfield Plain give way to sandstones and shales and their residual soils in the Osage Plains. The subsection extends slightly into Kansas and Oklahoma.

CLIMATE

Mean annual precipitation is 42–43 inches. The wettest months are April–June and September, and 57 percent of the annual precipitation occurs during the six warmer months of the year. Annual snowfall averages 12 inches. Mean January minimum daily temperature is 20–21°. Mean July maximum daily temperature is 91° in the west but only 89° in the east due to higher elevations. The growing season averages 208–210 days. Microclimatic variations, in general, are not significant because of the relatively low relief of this subsection.

Jim Rathert

The diminutive plant *Geocarpon* is a federally listed threatened species; most of its occurrences in the world are on channel sandstone glades in the Springfield Plain Subsection.

TOPOGRAPHY AND GEOLOGY

The subsection lies on the western end of the broad Ozark uplift. Strata generally dip gently westward. Because of its high structural position and less removal of the sedimentary cover of the uplift, the subsection has some of the highest elevations of the entire Ozark Highlands. The subsection is underlain mostly by various formations of the Mississippian period, most notably the very cherty limestones of the Burlington Formation. These relatively resistant but soluble limestones are responsible for a rather smooth plains surface of generally less than 100 feet of local relief, with several well-developed karst tracts. Sinkholes, springs, and caves are especially prominent in the Springfield area. Along the southeastern and northeastern boundaries the Burlington Escarpment breaks off sharply, forming a hilly belt of up to 250 feet of relief. Here, some of the valleys cut down into the Ordovician Jefferson City–Cotter Formation. The subsection is especially varied in lithology and landscape features in the north, where the escarpment disintegrates and streams more deeply dissect the plains. Relief here is 100–200 feet. A few narrow, long Pennsylvanian sandstone ridges rise slightly above the plain in its northern and central parts (eastern Lawrence County and north to Stockton Lake). On the subsection's west side, historic lead and zinc mining has scarified large areas, chiefly in Jasper and Newton Counties. Tripoli, used for polishing and in the manufacture of paint and paper, is mined in Newton County. Massive beds of highly resistant chert form waterfalls and cliffs along Shoal Creek in the Joplin area. Much of the plain can produce high-calcium limestone, and it is quarried mostly in the Springfield and Joplin urban areas.

SOILS

Most of the soils formed in materials weathered from cherty limestone, partly covered with a mantle of loess that thins to the east. In general, the soils are moderately deep to very deep, moderately well drained to well drained, and medium to fine textured. Soils on the nearly level to moderately sloping upland divides include the Newtonia and Wanda series, with thick dark surface layers; the Peridge series, with a thin surface layer; and soils with root-restricting fragipans in the subsoil, such as the Creldon, Hoberg, Keeno, and Viraton series. Soils on the moderately sloping to steep upland sideslopes generally have very cherty, red, loamy to clayey subsoils, and include the Goss, Eldon, Rueter, and Clarksville series.

HYDROLOGY

Lying at a comparatively high elevation, the subsection contains the headwaters and upper reaches of streams that drain radially off the plain into adjacent regions. These include the Sac River, which flows northward into the Osage River; the James River and Finley Creek, which flow southward into the White River; and Shoal Creek and Spring River, which drain most of the western portion of the subsection west into the Neosho River. Discharge is highest, on the average, in late winter and spring and declines rapidly during the summer and into fall. Flash floods are common, and major stream flooding also occurs on larger streams. Streams carry large bed loads of chert gravel and sand, and gravel bars and banks are typical of all streams. The streams carry little suspended sediment, except in times of high runoff and flooding. Springs are numerous and some are large. Spring flow is a major contributor to base flow on many streams and sustains perennial flow during dry periods. The subsection has natural ponds in sinkholes and solution depressions. Ponds built for livestock water number into the thousands. Some sizable lakes have been built for water supplies (Lakes McDaniel and Springfield). Stockton Lake is a large multipurpose reservoir on the Sac River. Small lakes also occupy mining pits and depressions in the Joplin area. Stream water is generally acceptable but can be seriously degraded in the Springfield and Joplin built-up areas and affected elsewhere by runoff from croplands and livestock and poultry operations. Groundwater is very abundant and generally of high quality, although the urbanized Springfield area experiences serious problems with groundwater contamination that are complicated by well-developed underground karst with rapid groundwater movement. Groundwater quality in the Joplin area may be affected by surface and subsurface lead and zinc mining.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The Springfield Plain is a transition zone from areas of nearly pure prairie on the west to more timbered areas to the east. Large tracts of prairie dominated much of the western half of the region. On the east, prairies occupied only the highest, flattest divides. Prairies graded into extensive oak savannas and then into oak woodland and forest in the most dissected lands. Some of the limestone woodlands likely had unusual compositions, with ash, sugar maple, and walnut sharing dominance with the oaks. Glades, sinkhole ponds, and depressional wetlands were scattered throughout.

Current. Fescue pasture and small, isolated woodlots of invasive trees and shrubs now dominate the subsection. Cropland is common on some former prairie areas in the northwest. Large blocks of second-growth timber are confined to the most rugged lands near rivers. Most glades are severely overgrown with eastern red cedar. High-quality natural communities are rare.

Major Natural Community Types

Midwest Dry-Mesic Chert and Limestone Prairies

Little Bluestem Hardpan Prairie

Central Post Oak Dry Barrens (Savanna)

Post Oak–Blackjack Oak/Bluestem Dry Chert Woodland

Chinquapin Oak–Ash (Eastern Red Cedar)/Bluestem Dry Limestone Woodland

White Oak–Black Oak Dry-Mesic Chert Woodland

White Oak–Mixed-Oak/Redbud Dry-Mesic Limestone Forest

Rare or Restricted Natural Communities. The chert, limestone, and hardpan prairies of the Springfield Plain were some of the most extensive of their type. Over 70 prairie remnants persist in the region, covering approximately 8,000 acres. Most of them are relatively small (less than 150 acres) and isolated in the northwestern part of the region. Intact, natural savannas and woodlands are virtually unknown. High-quality limestone and sandstone glades are very uncommon; some support federally listed plant species. The chert glades of the Joplin area are globally unique. Sinkhole ponds are now extremely rare, and fens are nonexistent. While caves are somewhat common, few pristine, high-quality caves are known. The stream communities of the region are some of the most distinctive in the state, but all are threatened to some degree by development, mining, and groundwater pollution.

NATURAL DISTURBANCES

Fire and grazing by bison, elk, and deer were principally responsible for the creation and maintenance of the glades and open woodlands indigenous to the region. Reintroduction of fire shows considerable potential for restoration.

RARE OR ENDANGERED SPECIES

The Springfield Plain Subsection is exceptionally rich in rare or endangered species; in fact no other subsection has more heritage records. The Heritage Database lists over 800 occurrences of 145 species in this subsection. Twenty-nine species are restricted mainly to this subsection (more than 80 percent of their occurrences are here), and most of these have fewer than 5 populations. These restricted species include numerous fish and mussels, many from Spring River and Shoal Creek. Others are unique cave dwelling animals, or near-endemics from glades in the region. These habitats, along with prairies, are also strongly associated with the listed species in the region. Twelve species are of federal concern. Ozark cavefish *(Amblyopsis rosae),* Ozark big-eared bat *(Corynorhinus townsendii),* and gray and Indiana bats *(Myotis grisescens* and *M. sodalis)* are federally listed cave-dependent species. Niangua darter *(Etheostoma nianguae)* and Neosho madtom *(Noturus placidus)* are fish of federal concern. Geocarpon *(Geocarpon minimum)* and Missouri bladderpod *(Lesquerella filiformis)* are near-endemics from glades in the region. Other federally listed species include western prairie fringed orchid *(Platanthera praeclara),* American burying beetle *(Nicrophorus americanus),* and Mead's milkweed *(Asclepias meadii).*

NATURAL AREAS

Despite the high diversity of communities, the Springfield Plain Subsection has only six designated Natural Areas. Diamond Grove Prairie, Niawathe Prairie, and Mount Vernon Prairie represent prairies of the region. Wildcat Glade protects a unique chert glade and Bona Glade protects a unique channel sandstone glade. Buffalo Hills represents oak woodlands at the edge of the Elk River Hills Subsection.

Missouri Department of Conservation

Missouri bladderpod is a federally listed endangered species; all of its known occurrences are on limestone glades in the Springfield Plain Subsection.

PUBLIC LANDS

The subsection contains more than 80,000 acres of public land, a relatively small amount in relation to its size. Most of this acreage (more than 60,000 acres) is associated with Stockton Lake. The Missouri Department of Conservation leases and manages much of the Stockton land and owns more than 17,000 acres of land in the region. Prominent Conservation Areas include Fort Crowder, Talbot, Compton Hollow, Bois D'Arc, Pleasant Hope, and Little Sac Woods. The only state park is Stockton Lake State Park. The National Park Service operates Wilson's Creek National Battlefield and George Washington Carver National Monument. The Nature Conservancy owns and manages several preserves in the region.

HUMAN GEOGRAPHY

Demographics. Indians were very active in this subsection before Americans arrived. The Great Osages, especially, had settlements and used the region for hunting. They burned the grasslands and timber. Various eastern Indians (Kickapoo, Shawnee, Delaware, and Cherokee) occupied parts of the subsection at various times in their westering movement. Americans early entered the region as hunters and Indian traders, but significant agricultural settlement was delayed until the late 1820s and 1830s because of distance from navigable waterways. All counties were erected by 1860. The Civil War ravaged much of the occupied parts of the plain, but plenty of public land was still available when social and political institutions were reestablished after the war. The people who early settled the region were from the middle-border states of Kentucky, Tennessee, and southern Indiana and Illinois. After the Civil War and railroad construction, settlers came from more northerly source regions and they came to dominate the cultural mix. Some localities received immigrants directly from Europe, primarily Germany. Population grew in the latter decades of the nineteenth century from both migration and natural population increase. Rural population peaked in the early nineteenth century. Rural losses since then have been greatly offset by the growth of Springfield, Joplin, Neosho, and

mining centers. Population growth continues very strong, well above the state average, at the beginning of the twenty-first century.

Economics and Land Use. Farming dominated the economy in the nineteenth century with emphasis on livestock, corn, and wheat. Fruit and vegetable growing was introduced after the turn of the century, but it collapsed. Dairying has expanded greatly in the latter half of the twentieth century in Greene and surrounding counties, which are now Missouri's leading dairy cattle region. Beef cattle continue to be important, and the more important crops include hay, sorghum, and wheat. A poultry industry has emerged, especially in Barry and Newton Counties. Livestock and poultry raising dominate the agricultural sector of the economy. Lead mining, which started as early as 1820, did not really grow until after the Civil War, when its major growth came with the introduction of railroads and the development of its coproduct zinc. Open-pit and subsurface mining concentrated in Jasper County, and Joplin arose as the center of the industry. All serious lead and zinc mining has ceased in the region. The current economy of the subsection is dominated by the diversified economies of Springfield and Joplin-Carthage. Both cities are major retailing and wholesaling centers, major service centers, and have major manufacturing industries. They exert a strong effect on land use throughout much of the subsection. Most of the land of the Springfield Plain is in grassland, and most of that is in improved pasture for dairy and beef cattle. Croplands (hay, sorghum, and wheat) occupy the best soils and smoothest lands on both the upland plain and bottomlands. The steepest slopes are in timber or woodland and are sometimes grazed, but they constitute a minor portion of the subsection. Wooded lands are proportionately more important in the north. Urban land use dominates in the Springfield and Joplin-Carthage areas and at Neosho and some smaller towns. Urbanization processes are especially strong in Christian County. Derelict mining lands are conspicuous locally.

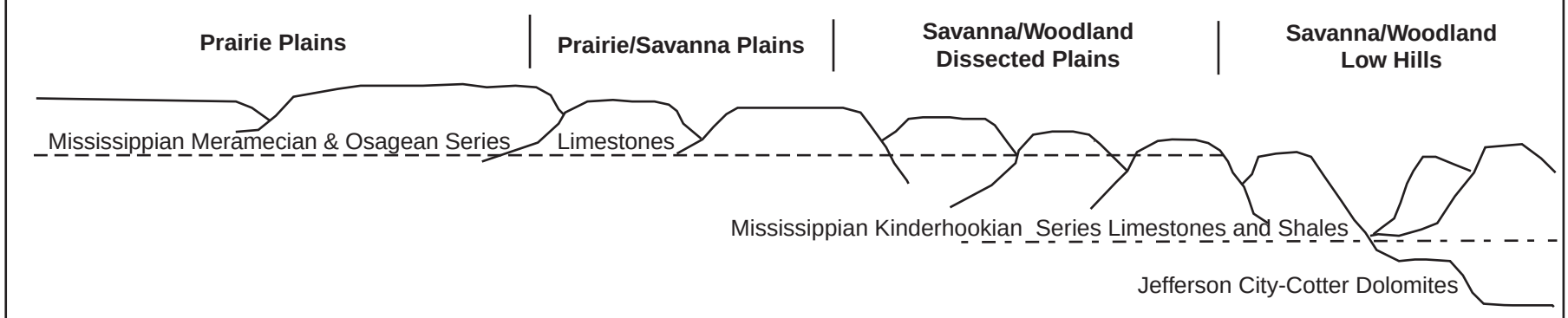
LANDTYPE ASSOCIATIONS

The Springfield Plain Subsection is subdivided into thirteen landtype associations (LTAs). In addition to broad alluvial plains, LTAs are differentiated mainly by the amount of relief and surface roughness and corresponding soil and vegetation patterns. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Springfield Plain is probably the ecoregion of the Ozark Highlands that is most altered by human activities. Native grasslands, savannas, and woodlands have been largely converted to pasture. Timbered areas tend to be small, isolated, and cut over or grown up in dense timber in the absence of fire. The subsection has one of the fastest growing populations of the state, and urbanization processes extend throughout much of the subsection. Though the current mosaic of native vegetation is a drastically altered one, numerous remnants of most terrestrial ecosystems remain. Stream systems are also substantially altered but contain opportunities to conserve rare fish and mussel species. The amount of public conservation lands is currently low. Conservation activities will require private and public land partnerships to pursue ecosystem restoration on a large scale. Restoration of the native grassland/woodland mosaic may not only benefit native plant and animal species, but could also provide forage and timber resources as well as watershed protection.

LANDTYPE ASSOCIATIONS IN THE SPRINGFIELD PLAIN SUBSECTION



(see landtype associations map pg. 156–157)

LANDTYPE ASSOCIATIONS IN THE SPRINGFIELD PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ1a Lockwood Smooth Prairie Plain	The LTA occupies a flat plain on the interfluve between the Neosho and Osage drainage basins in the northwestern part of the subsection. The boundary with the Osage Plains approximates the change from Mississippian to Pennsylvanian lithology and has a slight rise along parts of it. The southern and eastern boundaries are drawn to encompass the flat plains landform with less than 50 feet of local relief.	The LTA consists of a flat plain transitional to the more extensive Osage Plains to the northwest. Local relief is less than 50 feet throughout. The LTA is underlain chiefly by chert-free Mississippian limestones. Deep and poorly drained fragipan soils are characteristic. Historically the LTA was almost completely (more than 95 percent) tallgrass prairie; today it is mainly fescue pasture and hay meadows with scattered cropland. A high number of prairie remnants with associated rare species are located in the vicinity of Lockwood. A concentration of rare and near-endemic fish and mussel species occurs in the lower Spring River and its tributaries.
OZ1b Stockton Prairie/ Savanna Dissected Plain	The LTA occupies a slightly dissected plain associated with Cedar and Bear Creek tributaries to the Sac River north of (downstream from) Stockton Lake. The southern and northern boundaries mark an increase in relief to more than 150 feet. The western and eastern boundaries are placed where relief diminishes to less than 100 feet. The northeastern boundary with the Pomme de Terre Dissected Plain marks a transition to an LTA with a much greater prevalence of prairie. Stockton lies in this LTA.	The LTA is a rolling, dissected plain on highly varied geologic substrates. The western half is underlain mainly by Osagean series Mississippian limestones, while the eastern half is a mixture of various Mississippian limestones, Pennsylvanian sandstone and shale, and Ordovician Jefferson City–Cotter dolomite. Relief averages 100–150 feet. Valley forms are variable, with numerous rock outcrops on valley sides of slightly entrenched streams. High-discharge releases from Stockton Dam have severely eroded the Sac River channel below the dam. Historically, prairie occupied the flatter uplands and graded into oak savanna and woodland in more dissected areas. Today, most of the region is fescue pasture with scattered blocks of dense second-growth timber and occasional cedar thickets. A substantial number of small prairie remnants occur.

(table continued on pg. 92)

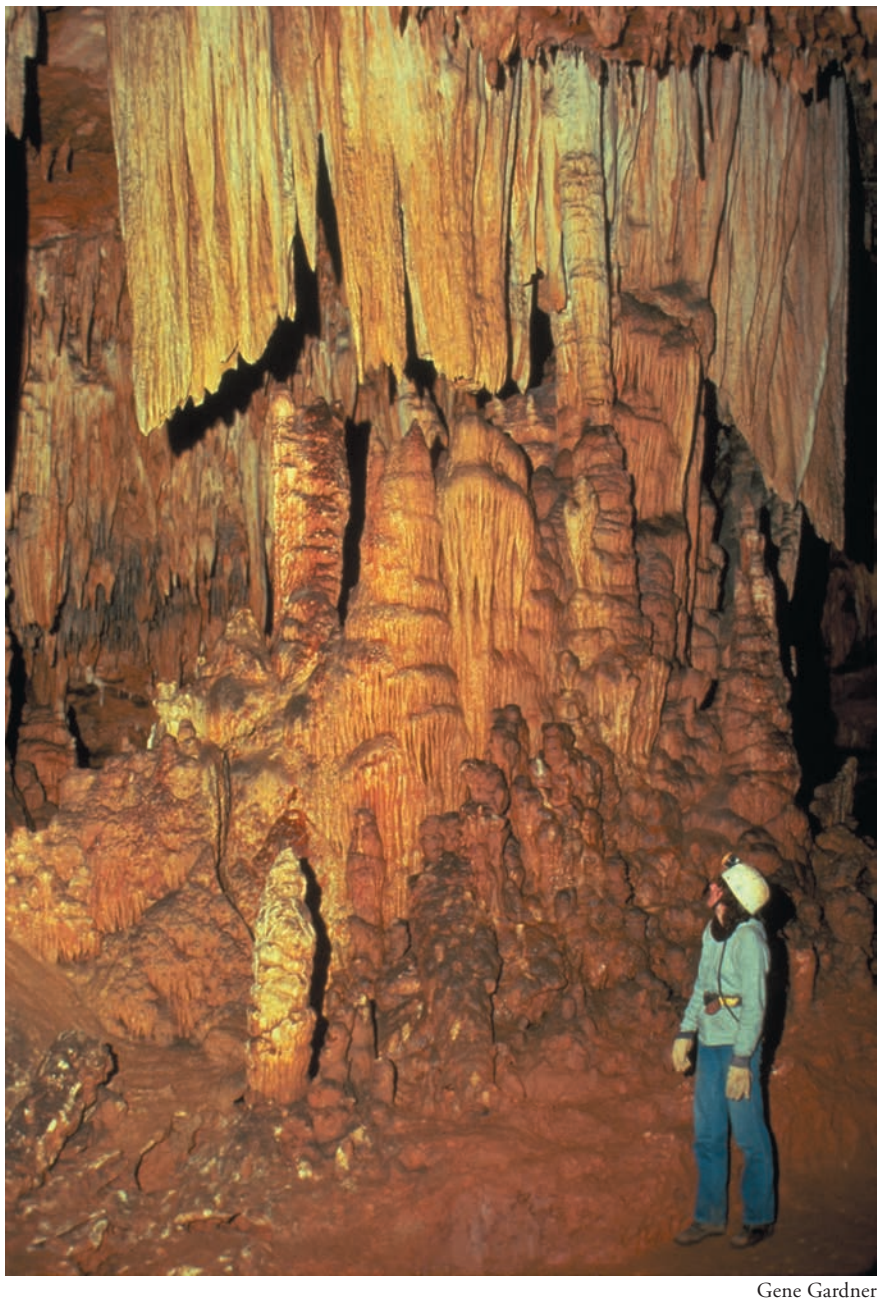
LANDTYPE ASSOCIATIONS IN THE SPRINGFIELD PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ1c Weaubleau Prairie/ Savanna Dissected Plain	The LTA occupies several high, gently rolling divides between the Sac and Pomme de Terre River basins. Boundaries are drawn mainly at 100 feet of local relief to encompass the high, flat landforms, but separated on the south from the Stockton dissected plain based on the dominance of historic prairie in this LTA.	The LTA consists of smooth upland plains that were historically dominated by prairie. Land slopes off rapidly from the plains to the surrounding hills. The LTA is underlain by a mixture of Mississippian limestones and Pennsylvanian sandstone and shale. This LTA was originally dominated by tallgrass prairie, grading into oak savanna on its edges. Today, the landscape is mainly fescue pasture with scattered blocks of second-growth timber. Several prairie remnants and a channel sandstone glade with *Geocarpon* are in the LTA.
OZ1d Lost Creek Oak Savanna/ Woodland Low Hills	The LTA occupies a deeply dissected area along Lost Creek at Seneca in southwestern Newton County. Boundaries are drawn to encompass a hilly area with over 150 feet of local relief.	The LTA consists of a very small area in the upper reaches of Lost Creek with deeply dissected hills. Relative relief is over 150 feet. The unusual depth is due to solution work in Mississippian chert-free limestones. Historically oak savanna and woodland, today it is mainly pasture with several large blocks of dense second-growth forest.
OZ1e Shoal Creek Oak Savanna/ Woodland Low Hills	The LTA occupies a narrow belt of hills flanking Shoal Creek across Newton County. Boundaries are drawn on the rather abrupt break from the plains surface into steeper lands along the stream valley. Neosho is in this LTA.	The LTA consists of steep-sided hills along Shoal Creek with local relief of up to 200 feet. Mississippian limestones produce cliffs, bedrock shoals, and low falls. Included are unique outcrops in the stream and on valley sides of the Grand Falls chert, an unusually thick bed of chert. The LTA includes globally unique chert glades and near-endemic rare fishes and mussels. Historically oak savanna and woodland with scattered glades, the LTA is now a mosaic of pasture and dense second-growth oak forest. Several chert glades are intact and protected. Joplin and Neosho are spreading into the hills of this LTA.
OZ1f Spring River Prairie/ Savanna Dissected Plain	The LTA occupies a very large, flat to gently rolling plain drained mainly by the Spring River and Shoal Creek. It encompasses large parts of Lawrence, Barry, Newton, and Jasper Counties. Most boundaries are drawn where the flat to minimally dissected plain gives way to hills of more than 100 feet of local relief. The boundary on the north, however, is drawn where the relief flattens out even more and stream valleys are less dissected. The western boundary is the Kansas state line, and a southward extension of the LTA reaches the Arkansas state line at Seligman. I-44 and US 60 cut across the LTA.	The LTA consists of an extensive, flat to gently rolling plain. Broad upland surfaces with less than 75 feet of local relief give way sharply to steep-sided but shallow stream valleys with less than 150 feet of relief. The effect is that of a tableland sharply entrenched at wide intervals by subparallel streams draining westward. The LTA is underlain by cherty, soluble Mississippian limestones that have copious groundwater that issues in numerous springs in the bedrock-walled valleys. In Lawrence County, channel sandstone creates low ridges above the general surface. Historically prairies dominated the broad flats, while oak and mixed-hardwood savannas occupied areas of greater relief. Scattered limestone and sandstone glades occurred at rock outcrops. Today, the LTA is 90 percent fescue pasture and hay meadows with scattered small patches of cropland and dense, invasive timber. The LTA has numerous rare fish and mussel locations, many found only here in Missouri. In addition, many small prairie remnants and several caves with rare and unique fauna exist. Public lands are very limited.
OZ1g Springfield Karst Prairie Plain	The extremely irregularly shaped LTA occupies several flat upland divides radiating out from Springfield in all directions. Boundaries are drawn to encompass the high plain with less than 75 feet of local relief. The boundary with the Spring River Plain is placed where surface karst features become much less common.	The LTA consists of several flat plains on the divides between several tributaries of the Sac and James River basins. Local relief is less than 75 feet. The plain is underlain by the highly soluble Osagean series of Mississippian limestones, and karst features distinguish the LTA. Sinks, pinnacled rock, losing streams, and other karst features occur on all the various segments of the plain but are especially numerous around Springfield and on the flat divide at Nixa in Christian County. Surface streams are few and ephemeral. Limestone is mined at several quarries. Historically, the LTA had large areas of prairie on the highest, flattest areas, which graded into oak and mixed-hardwood savannas in sinkhole-infested tracts. Today, the LTA is highly urbanized in many places, and in nonurbanized areas it is mainly fescue pasture and hay meadows. The LTA has many caves with unique animal species, as well as several *Geocarpon* and Missouri bladderpod glades.

LANDTYPE ASSOCIATIONS IN THE SPRINGFIELD PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ1h Upper Sac River Oak Savanna/ Woodland Low Hills	The LTA occupies hills associated with the upper Sac River and its tributaries around and above Stockton Lake. Boundaries are drawn to enclose hills with over 150 feet of local relief.	The LTA consists of moderately dissected hills with 150–200 feet of local relief, underlain mainly by Osagean series of Mississippian limestones. Some narrow low ridges formed by channel sandstones occur in western parts. Historically the LTA was dominated by oak savanna and woodland with scattered prairie openings and limestone glades. Today it is mainly fescue pasture and hay meadows with small blocks of dense second-growth oak forest on rougher ground. Limestone and sandstone glades are usually overgrown with eastern red cedar and other woody invaders. A high percentage of near-endemic *Geocarpon* and Missouri bladderpod glades occur in this LTA. In addition, several important rare-animal caves are found here.
OZ1i Little Sac River Oak Savanna/ Woodland Low Hills	The LTA occupies hills associated with the upper Little Sac River above Stockton Lake in Polk and northern Greene Counties and stretches eastward to I-44. Boundaries enclose hills with relief of over 150 feet. The northeastern boundary is the sharply defined Burlington Escarpment.	The LTA consists of broad uplands associated mainly with Osagean series of Mississippian limestones that give way to moderately steep and dissected hills cut into Meramecian series of limestones and then into the Ordovician Jefferson City–Cotter Formation. Slopes can take a variety of shapes, with numerous rock ledges. Historically, the LTA was dominated by oak savanna and woodland with occasional glades and prairie openings. Today, it is mainly fescue pasture and hay meadows with small blocks of dense second-growth oak forest on rougher ground. Occasional limestone glades are usually overgrown with eastern red cedar and other woody invaders. A high percentage of near-endemic Missouri bladderpod glades occur in this landscape.
OZ1j James River Oak Savanna/ Woodland Low Hills	The LTA occupies moderately dissected hills associated with the upper James River. Boundaries enclose hills with relief of over 150 feet. The downstream boundary with the White River Hills Subsection marks an increase in local relief above 250 feet and more rugged topography in general.	The LTA consists of gently rolling hills associated mainly with Osagean series of Mississippian limestones that give way to moderately steep and dissected hills cut into Meramecian series of limestones and then into the Ordovician Jefferson City–Cotter Formation. Springs are numerous in this LTA, drawing off groundwater from the Springfield Karst Plain into which the James River is dissected. Historically, the LTA was dominated by oak savanna and woodland with occasional glades and prairie openings. Today, it is mainly fescue pasture and hay meadows with small blocks of dense second-growth oak forest on rougher ground. Limestone glades are usually overgrown with eastern red cedar and other woody invaders. A high percentage of near-endemic Missouri bladderpod glades and several caves with rare animals occur in this landscape. The middle parts of the LTA in Greene and Christian Counties are under great development pressures from the Springfield metropolitan area. The James River is degraded.
OZ1k Finley River Oak Savanna/ Woodland Low Hills	The LTA occupies hills associated with the upper Finley River. Boundaries encompass hills with relief of over 150 feet. The southeastern boundary with the White River Hills Subsection marks a distinct change to much rougher lands with higher relief.	The LTA consists of gently rolling hills associated mainly with Osagean series of Mississippian limestones that give way to moderately steep and dissected hills cut into Meramecian series limestones and then into the Ordovician Jefferson City–Cotter Formation. Many springs along Finley Creek drain off water from the adjacent karst uplands. Historically, the LTA was dominated by oak savanna and woodland with occasional glades and prairie openings. Today, it is mainly fescue pasture and hay meadows with small blocks of dense second-growth oak forest on rougher ground. Occasional limestone glades are usually overgrown with eastern red cedar and other woody invaders. Several caves with rare animals occur in this landscape. The LTA is experiencing major commercial and residential development around Ozark.
OZ1l Sparta Oak Savanna Plain	The LTA occupies a high, narrow upland divide between Finley River and Bull Creek. Boundaries are drawn where local relief increases above 100 feet at the edge of the plain.	The LTA occupies a narrow upland divide at the south edge of the Springfield Plain Subsection. Local relief is mainly less than 75 feet and karstic in places. The plain is underlain principally by Osagean series of Mississippian limestones. Historically it was oak savanna with scattered prairie openings. Today it is nearly all fescue pasture and hay meadows. Recreational development is occurring along highways.

(table continued on pg. 94)

LANDTYPE ASSOCIATIONS IN THE SPRINGFIELD PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ1m Seymour Highland Oak Savanna/Woodland Dissected Karst Plain	The LTA occupies a high divide between the James, Gasconade, and White River basins at the eastern tip of the Springfield Plain Subsection. Boundaries are drawn generally at 100 feet of local relief to encompass the high, flat plain. It is separated from the Springfield Plain LTA to the west based on lack of historic prairie. The prominent Burlington Escarpment, which marks a change in topography and lithology, forms the northwestern boundary with the Central Plateau Subsection and the southeastern boundary with the White River Hills Subsection.	The LTA consists of the highest general upland surface of the Ozarks and thus Missouri; some portions of the flat plain are above 1,700 feet. The LTA is underlain by the Burlington Formation of soluble Mississippian limestones. Local relief is less than 75 feet and is caused mostly by solution swales and some sinkholes; streams are absent or are ephemeral. Historically oak savanna and woodland, the LTA today is nearly all fescue pasture with residential and commercial development along US 60.

The Springfield Plain is known for its numerous beautiful caves.



Gene Gardner

OZ3
ELK RIVER HILLS SUBSECTION

(see map pg. 156–157)

(INCLUDING OZ2 SPRINGFIELD PLATEAU SUBSECTION)

GENERAL DESCRIPTION

The Elk River Hills Subsection consists of the moderately dissected portion of the Elk River drainage basin. Steep slopes, narrow ridges, and narrow valley bottoms prevail. A small portion of the Springfield Plateau Subsection, more widespread in Arkansas, is included here. Relief is generally 150–250 feet, but in the very small Springfield Plateau Subsection it is less than 150 feet. Soils are mainly deep, cherty loams formed from cherty Mississippian limestones, but shallow to moderately deep soils over limestone bedrock occur locally. Presettlement vegetation was oak savanna and woodland, with isolated tracts of oak-pine woodland and, in the Springfield Plateau Subsection, prairie. Forests and woodlands dominate the landscape today, with cleared land restricted to valley bottoms and some ridges.

LOCATION AND BOUNDARIES

The small Elk River Hills Subsection lies in the Ozark Highlands of extreme southwestern Missouri. It comprises most of McDonald County and small portions of Newton and Barry Counties. It is defined on the basis of moderately deep dissection along the Elk River and its tributaries. The northern and eastern boundaries with the Springfield Plain are drawn on the basis of 150 feet of local relief. In Barry County and northeastern McDonald County the boundary is sharp and conspicuous in the landscape. Elsewhere the boundaries are the state lines with Arkansas and Oklahoma. The subsection extends slightly into both of those states. A very small portion of the Springfield Plateau Subsection in the southwestern corner of Missouri is incorporated in the discussion here, because its small extent in Missouri does not warrant separate treatment. The Springfield Plateau Subsection is much more extensive in northeastern Oklahoma and northern Arkansas.

CLIMATE

Mean annual precipitation is 43 inches. The wettest months are May–June and September, and 58 percent of the annual precipitation occurs during the six warmer months of the year (at Anderson). Annual snowfall averages 10 inches. Mean January minimum daily temperature is 21°. Mean July maximum daily temperature is 90°. The growing season averages 208 days. Significant microclimatic variations occur locally because of the high relief of the land.

TOPOGRAPHY AND GEOLOGY

The Elk River Hills Subsection lies on the western flank of the Ozark uplift, but the westward dip is so barely perceptible that strata appear to be horizontal. The subsection is mostly underlain by very cherty limestones of the Burlington and other Mississippian formations. The deepest valleys cut through Devonian limestones and into the Ordovician Jefferson City–Cotter Formation. Springs are common, but sinkholes and losing streams are not. Surficial materials are clayey with large amounts of rock fragments, chiefly chert. Local relief is moderately high, 150–350 feet, but drops to less than 100 feet in the extreme southwestern corner of the state. The surface is thoroughly dissected into narrow ridges and narrow valleys with steep slopes. Bold cliffs are common.

SOILS

Most of the soils were formed in materials weathered from cherty limestone. Backslopes are extensive in this subsection and are a mixture of deep soils with red, very cherty, loamy or clayey subsoils, such as the Noark, Crackerneck, and Clarksville series, alternating with shallow soils over limestone bedrock in glades, such as the Moko and Blueye series. The narrow, convex ridges have intermittent fragipans in the subsoil, but the root-restricting fragipans are not abundant in this subsection. Floodplains are narrow and not extensive, with very gravelly soils such as the Cedargap series.

HYDROLOGY

The Elk River Hills Subsection lies entirely within the Elk River drainage basin, a tributary of the Neosho River in Oklahoma, part of the Arkansas River system. Stream gradients are moderately steep. Streams carry sizable bed loads of sand and gravel, and their channels contain gravel and sandbars. Suspended sediment load is relatively slight. Streamflow is highest in late winter and spring and declines during summer and early autumn. Flash floods occur on the streams after high-intensity rains and protracted rainy periods. Natural flooding occurs; there are no flood-control structures of consequence. Springs are numerous and contribute significantly to the base flow of streams. The subsection lacks natural lakes and ponds, although numerous small ponds have been constructed for livestock watering. Water quality in general is very good, but it is at risk of being seriously degraded by runoff from poultry-raising activities. Groundwater is abundant and generally of high quality.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The Elk River Hills Subsection was historically a region of oak savanna

Tim Nigh

Fire maintained, open oak woodlands would have historically dominated the Elk River Hills.

and woodland. Proximity to prairie ecoregions and relatively poor soils limited the density of timber and favored grassland species. Cherty ridgetops supported isolated oak-pine woodlands. Glades and small prairie openings also occurred throughout.

Current. Today the region is largely timbered in dense second-growth mixed-oak forest. The density of the former woodlands has increased in the absence of fire. Most bottoms and many ridges are now cleared pasture. Glades are largely overgrown with eastern red cedar.

Major Natural Community Types

Central Post Oak Dry Barrens (Savanna)

Post Oak–Blackjack Oak/Bluestem Dry Chert Woodland

Chinquapin Oak–Ash (Eastern Red Cedar)/Little Bluestem Dry Dolomite Woodland

White Oak–Black Oak Dry-Mesic Chert Woodland

Mixed Oak–Hickory/Dogwood Dry-Mesic Chert Forest

White Oak/Dogwood Dry-Mesic Chert Forest

White Oak–Mixed Oak/Redbud Dry-Mesic Limestone/Dolomite Forest

Rare or Restricted Natural Communities. Like the adjacent White River Hills, this ecoregion was a principal location of widespread oak savanna and woodland. This includes limestone woodlands that are restricted in their distribution in Missouri. There are also small local occurrences of pine-oak woodlands. Few quality remnants remain due to fire suppression. Reintroduction of prescribed fire on a small scale shows great restoration potential, but the practice could be applied on a wider scale. Numerous limestone glades suffer woody encroachment. Outstanding limestone cliff communities and springs are rare.

NATURAL DISTURBANCES

Fire and grazing by bison, elk, and deer were principally responsible for the creation and maintenance of the glades and open woodlands indigenous to the region. Reintroduction of fire shows high potential for restoration.

RARE OR ENDANGERED SPECIES

This ecoregion contains 108 records of 34 state-listed species. This includes two that are federally listed: gray bat *(Myotis grisescens)* and bald eagle *(Heliaeetus leucocephalus)* (nesting or roosting). In addition, three species have their only Missouri occurrences here: Virginia whitlow grass *(Paronychia virginica* var. *scoparia),* slim tridens grass *(Tridens muticus* var. *elongates),* and chert pebble snail *(Somatogyrus rosewateri).* Many of the rare species are associated with cliffs, glades, and streams.

NATURAL AREAS

There is only one designated Natural Area in this region, Buffalo Hills. It contains a representative landscape with many of the oak woodland and forest communities indigenous to the region.

PUBLIC LANDS

There are only 8,100 acres of public land in the region. Most of these acres are contained in three Conservation Areas—Buffalo Hills, Huckleberry Ridge, and Flag Spring—and one state park, Big Sugar Creek.

HUMAN GEOGRAPHY

Demographics. Indians, chiefly Osages, had settlements along the rivers and used the land for hunting before Americans entered. Americans, mostly from Tennessee and Appalachia, began arriving in the 1830s and 1840s to establish permanent settlements. The strong mixture of Indians in the population today is associated with the various Indian nations living in adjacent Oklahoma. Rural population peaked in the early nineteenth century, then declined until the 1970s, when it began to rise again. Recent strong population growth, much of it Hispanic, is associated with economic growth in adjacent northwestern Arkansas.

Economics and Land Use. Early settlers had small fields of corn and other crops in the bottomlands and used the wooded hills as open range for cattle and hog raising. The best lands were occupied by the time of the Civil War. Following the economic and social disruption of the war, immigration was renewed and the rural population spread onto ridgetop farms. Without good transport facilities, the economy remained semisubsistent until well into the twentieth century. Later changes in the agricultural economy caused numerous submarginal farms to be abandoned, and those remaining emphasized livestock. Fruit-growing has been introduced.

The Elk River Hills Subsection is mostly in forests and woodlands, some of them grazed. Pasture occupies most bottoms and smooth ridges and row crops are virtually absent. Urban land use is a tiny proportion of the total area. In the later decades of the twentieth century a vigorous poultry industry emerged, the northern extension of an even larger concentration in adjacent northwestern Arkansas. The poultry industry is concentrated in buildings on very small amounts of land, but waste products pose a risk to soil and water quality. McDonald County leads the state in numbers of chickens. Small-scale recreation was introduced early in the century, but it has not grown to the immense size of the industry in the White River Hills Subsection.

LANDTYPE ASSOCIATIONS

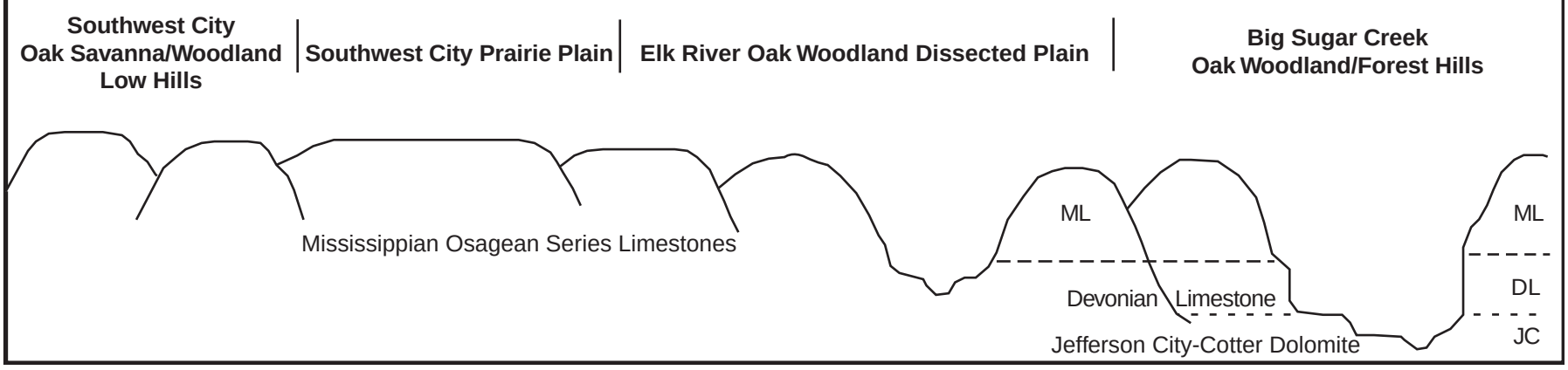
The Elk River Hills and Springfield Plateau Subsections are subdivided into four landtype associations (LTAs). The Elk River Hills have two distinct landscapes: the more rugged area associated with Big Sugar Creek on the east, and the less rugged landscape associated with Buffalo and Indian Creeks on the west. The small piece of the Springfield Plateau Subsection also has two distinct landscapes: a flat prairie plain, and a more hilly area. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

Limited efforts to restore the widespread oak savanna and woodland communities have been undertaken on public lands. More widespread restoration of woodland complexes and limestone glades distinctive to this ecoregion is a principal challenge. Integrating grazing and wood utilization with restoration activities may increase the economic value of the resources. Careful use of prescribed fire is essential. Efforts to improve the riparian corridors of the streams would also be beneficial.

LANDTYPE ASSOCIATIONS IN THE ELK RIVER HILLS SUBSECTION

(Includes minor portion of OZ2 Springfield Plateau Subsection)



(see landtype associations map pg. 156–157)

LANDTYPE ASSOCIATIONS IN THE ELK RIVER HILLS AND SPRINGFIELD PLATEAU SUBSECTIONS	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ2a Southwest City Prairie Plain	This is a flat to gently rolling plain in the southwestern corner of Missouri that extends well into Arkansas as part of the more extensive Springfield Plateau Subsection. Boundaries encompass the low-relief landform.	This is a flat to gently rolling plain, underlain by Mississippian limestones, that was historically prairie. Today the region is mainly pasture with isolated patches of cropland and timber.
OZ2b Southwest City Oak Savanna/ Woodland Low Hills	This is a very small area at the southwestern corner of Missouri around Southwest City that extends well into Arkansas. It is also part of the more extensive Springfield Plateau Subsection. Boundaries encompass the higher relief on the southwestern side of the historic prairie.	A small area of low hills around Southwest City with up to 200 feet of local relief. Historically oak savanna and woodland, it is now composed of pastures and blocks of second-growth timber.
OZ3a Big Sugar Creek Oak Woodland/ Forest Hills	This landscape consists of hills of the Big Sugar Creek basin as far west as Noel. The northern and eastern boundaries are based on an abrupt change in relief at the border of the Springfield Plain Subsection. The western boundary defines a change to lower relief along the Elk River, and the southern boundary is the state line with Arkansas.	Broad ridges at the borders of this landscape give way to narrow ridges, steep slopes, and cliffs along the streams. Valleys are cut into Mississippian limestones, Devonian limestones, and the Jefferson City–Cotter Formation. Soils range from fragipans on higher flats to deep cherty loams, but often thin to bedrock as in limestone glades. Historic land cover was oak savanna, woodland, and forest with scattered oak-pine ridges and limestone glades. Today it is mainly dense second-growth oak forest with valleys and flat uplands in pasture. Overgrown glades, isolated oak-pine stands, and unmodified cliffs are common. Several large tracts in state ownership offer conservation opportunities and public access.
OZ3b Elk River Oak Woodland Dissected Plain	The LTA consists of strongly rolling hills associated with the Elk River, Buffalo Creek, and Indian Creek valleys. Most boundaries are associated with the change to the lower relief of the Springfield Plain. The southeastern boundary with Big Sugar Creek Hills puts the higher-relief, Devonian-limestone area near the Elk River junction into a different landscape to the east.	This strongly rolling set of hills that flank three converging stream systems is underlain entirely by Mississippian limestones. Historically it was in oak savanna and woodland. Today it is a mixture of large patches of pasture in bottoms and on smooth ridge crests with variably sized patches of dense second-growth oak forest.

OZ4
WHITE RIVER HILLS SUBSECTION

(see map pg. 158–159)

GENERAL DESCRIPTION

This subsection consists of the deeply dissected portion of the White River drainage basin. It includes Table Rock, Taneycomo, Bull Shoals and North Fork Lakes—all reservoirs on the White River—and the basins of numerous south-flowing streams like Bryant Creek and the North Fork River. Steep slopes, narrow ridges, and narrow valley bottoms prevail throughout. Relief is as high as 600 feet. Soils are rocky and thin over carbonate bedrock. High, rolling divides occur on uplands farthest from the major streams. Areas of rugged dolomite knobs are also characteristic. Local karst, losing streams, and large springs are characteristic. Presettlement vegetation was dominated by extensive dolomite glade and woodland complexes, oak woodland, and oak-pine woodland and forest. Dolomite glades, the most extensive in Missouri, support numerous rare or endemic species. Dense second-growth forests and cedar thickets on former glades dominate the landscape today, with cleared land in valley bottoms and in less dissected upland areas. Substantial glade and woodland restoration is under way, but most areas lack attention. Much of the area is in public lands. Urbanization pressures are great around all of the large lakes.

LOCATION AND BOUNDARIES

The White River Hills Subsection lies within the Ozark Highlands of southwestern Missouri on the southern side of the Ozark regional drainage divide. It includes all of Taney County, almost all of Ozark, Douglas, and Stone Counties, large portions of Barry and Christian Counties, and small portions of Webster, Wright, Texas, and Howell Counties. Most of the northern boundary occurs along a rather abrupt topographic break along the White River basin drainage divide. Other boundaries are drawn where the higher local relief of this subsection declines to less than 150 feet of local relief. The northwestern boundary with the Springfield Plain is along the Burlington Escarpment, which separates the Ordovician formations of this subsection from the Mississippian formations of the Springfield Plain. In several places it is a very sharp line in the landscape. However, along major streams like the James River, deep dissection obscures the escarpment and makes the boundary an extremely irregular line. The Arkansas state line forms the southern boundary; the subsection extends well into Arkansas. (A very small fragment of national subsection 222An, Springfield Plateau Subsection, in southern Stone County, has been incorporated into this subsection. Subsection 222An is much more extensive in Arkansas and Oklahoma.)

CLIMATE

Mean annual precipitation is 43 inches. The wettest months are March–June and 56 percent of the annual precipitation occurs during the six warmer months of the year (at Ozark Beach). Annual snowfall averages 10 inches. Mean January minimum daily temperature is 21°. Mean July maximum daily temperature is 90°. The growing season ranges from 208 days in the north to 215 days in the south. Significant microclimatic variations occur locally because of the high relief of the land.

TOPOGRAPHY AND GEOLOGY

This subsection lies on the southern flank of the Ozark uplift. Strata dip very gently southward, but so slightly that they appear locally to be horizontal. In the east, streams have cut down into the thick, cherty dolomites and sandstones of the Gasconade and Roubidoux Formations (Ordovician), but most of the subsection is underlain by thick, cherty, and shaley dolomites of the Ordovician Jefferson City–Cotter Formation. The higher ridges in the western portion are underlain by very cherty limestones of the Burlington and other Mississippian formations. The strong Burlington Formation is also responsible for the high, narrow ridges of the glade country and other isolated high hills and knobs. The soluble carbonate rocks produce local karst landscapes. Karst features are more common in the eastern than in the western portions. Surficial materials are clayey with numerous rock fragments, chiefly chert, which is left behind as the carbonate rocks dissolve or decompose into clay. Human land use has intensified the percentage of rock fragments in the residuum by causing fines to be washed away, up to as high as 70 percent on some slopes. Local relief throughout the subsection is high, 300–800 feet; highest relief is in the western portion. The surface is thoroughly dissected into narrow ridges and narrow valleys with steep slopes. There is little flat land anywhere. A special region is the "glade country," where considerable bedrock is exposed as ledges that encircle knobs, hills, and ridges as land contours.

Richard Thom

Fires occurred at least every three years in the White River Hills region prior to European settlement, but their frequency diminished to one every twenty years thereafter.

SOILS

Most of the soils were formed in materials weathered from the Mississippian and Ordovician limestones and dolomites. In general, soils weathered from the Ordovician dolomites are higher in soluble bases such as calcium and magnesium than are soils weathered from Mississippian limestones. Deep, low-base soils with red, cherty, loamy to clayey subsoils on backslopes include the Noark, Clarksville, and Haley series. Pine-oak woodlands thrive on these highly weathered soils. Backslopes with deep soils weathered from Ordovician limestone include the Rueter, Goss, and Sonsac series. These soils can support rich forest communities. The extensive glades in this subsection have shallow soils such as the clayey Gasconade series or the loamy Moko series. Soils with root-restricting fragipans in the subsoil are on the convex ridgetops, where Nixa and Scholten are typical soil series, as well as on footslopes, where Britwater and Pomme series occur. Floodplains are narrow and not extensive, with very gravelly soils such as the Cedargap series.

HYDROLOGY

The subsection lies entirely within the White River drainage basin and includes its major tributaries: North Fork (Norfork), Bryant Creek, Beaver Creek, Swan Creek, and the major portion of the James River basin. Stream gradients are steep. Streams carry immense bed loads of sand and gravel, and their channels contain numerous gravel and sandbars. Suspended sediment load is generally slight, although periods of high-intensity rain and runoff from the Springfield Plain increase the turbidity of the James River. The White River at Branson has an annual mean discharge of 3,967 cubic feet per second, which is regulated by outflow from Table Rock Lake. Flow on other streams is highest in late winter and spring, on the average, and declines during summer and early autumn. Flash floods often occur on the smaller streams after high-intensity rains and protracted rainy periods. Springs are numerous and contribute significantly to the base flow of the tributaries of the White River. The subsection lacks natural lakes and ponds, except for sinkhole ponds, but large numbers of ponds have been constructed for livestock watering, especially in Douglas and Ozark Counties. Water quality in general is very good, except where runoff from built-up areas degrades it. The White River has been completely impounded in Missouri and exists only as a series of lakes—Table Rock, Taneycomo, and Bull Shoals—that are hydrologically related. For example, Taneycomo is especially cold from the water that leaves deep Table Rock Lake. Also, Taneycomo's bottom configuration has been altered by sediment redistribution from currents and increased velocities from the spillwaters of Table Rock Lake. Groundwater in the subsection is abundant and subject to serious contamination from urbanization and residential developments, especially in the Table Rock and Taneycomo areas. Much of the upland surface is karstic, and headwater streams are frequently dry or lose their flow to underground water.

TERRESTRIAL NATURAL COMMUNITIES

Historic. This subsection contrasts markedly with others within the Ozark High-

lands. It is known for its "bald knobs," former areas of dolomite glades that occupied the tops of knobs, hills, and extended ridges. The White River Hills dolomite glade communities supported a wide variety of unique and endemic plants. The glades graded into open-oak savannas and woodlands. Low slopes and bottoms were forested in oak and mixed deciduous hardwood species, and cane thickets or "breaks" were common in the bottoms. Some oak-pine forest and woodland occurred on high cherty ridgetops, especially in the eastern half of the subsection.

Current. Most of the dolomite glades and open woodlands of the ecoregion have grown up in eastern red cedar and other invasive woody species. Extensive acreages of cedar-hardwood thickets exist. Where still open, glades are often overgrazed and have lost their richness of unique and endemic species. Glade restoration on state and federal lands, while limited in its total acreage, exhibits great potential. Forest still occupies a major component of the landscape but has significantly changed in response to fire suppression, repeated timber harvest, and grazing. Many bottoms are cleared for pasture or submerged by lake water. Cane thickets are uncommon.

Major Natural Community Types

Ozark Dolomite Glade

Chinquapin Oak–Ash (Eastern Red Cedar)/
Little Bluestem Dry Dolomite Woodland

White Oak–Mixed Oak/Redbud Dry-Mesic Limestone/Dolomite Forest

Post Oak–Blackjack Oak/Little Bluestem Dry Chert Woodland

Post Oak–Black Oak–White Oak Dry-Mesic Chert Woodland

White Oak–Black Oak Dry-Mesic Chert Woodland

Shortleaf Pine–Oak–Vaccinium Dry Chert Woodland

Rare or Restricted Natural Communities. White River dolomite glades have a unique flora. While still relatively common, most glades and adjacent woodlands suffer from woody invasion and overgrazing by livestock. High-quality examples are the exception. Pine-oak woodland communities are also dense and overgrown in the absence of fire. Impressive dolomite cliffs occur along White River and distinctive moist cliff communities occur in the North Fork basin. Fens and sinkhole ponds are rare, but do occur. Bottomland forest with cane thickets are much less extensive than historically.

NATURAL DISTURBANCES

Fire and grazing by bison, elk, and deer were principally responsible for the creation and maintenance of open glades and open woodlands indigenous to the region. Reintroduction of fire shows potential for restoration.

RARE OR ENDANGERED SPECIES

The White River Hills Subsection contains more than 550 records of 142 state-listed species. Federally listed species from the region include five cave-associated species: Ozark cavefish *(Amblyopsis rosae),* Tumbling Creek cave snail *(Antrobia culveri)* and Ozark big-eared, Gary, and Indiana Bats *(Corynorhinus townsendii ingens, Myotis grisescens,* and *M. sodalis);* there are also records for bald eagle *(Heliaeetus leucocephalus)* nests or roosts. An exceptionally high number of listed species are associated with dolomite glades and woodland complexes of the region; many of these species are restricted to this ecoregion. Thirty-two additional species have their principal distributions in Missouri within this subsection. Other important habitats include caves, rivers and streams, and cliffs. Unique stream communities are threatened by lake-oriented residential and recreational development.

NATURAL AREAS

Nine Natural Areas are in the White River Hills Subsection. Outstanding dolomite glade complexes are at Haden Bald, White River Balds, Caney Mountain, and Butler Hollow Glades. Cliff communities are represented at Carman Springs and Rock Spring Bluff. Carman Springs also has outstanding Ozark creeks, as does Bryant Creek. An unusual xeric limestone woodland occurs at Ashe Juniper. Significant old-growth upland forest is represented at Roaring River Cove Hardwoods.

PUBLIC LANDS

The White River Hills Subsection has more than 400,000 acres of public land, an exceptionally high amount, second only to the Current River Hills. Most of the public lands are federally owned. More than 300,000 acres occur in the Ava, Cassville, and Willow Springs units of the Mark Twain National Forest. They include three Wilderness Areas: Hercules Glades, Devil's Backbone, and Piney Creek. An additional 100,000 acres are in U.S. Army Corps of Engineers lands associated with the lakes. The Missouri Department of Conservation leases and manages many of these acres; it also owns more than 23,000 acres, including the large Conservation Areas of Busiek, Caney Mountain, Drury-Mincy, and Shannon Ranch. Roaring River and Table Rock State Parks are in this subsection.

Collared lizards, which can grow to a foot in length, are common on the desertlike glades of the White River Hills Subsection.

Missouri Department of Conservation

HUMAN GEOGRAPHY

Demographics. Indians were quite active in this subsection before Americans entered. They had settlements along rivers, used the land for hunting, which included burning it, and had major trails across the region. In the early nineteenth century several westering Indian groups (Kickapoo, Delaware, Shawnee, and Cherokee) also lived in the subsection. The first Americans in the 1820s and 1830s were hunters, trappers, and Indian traders who entered the region by coming up the White River. Permanent settlers with a subsistence economy followed them in the 1830s. They had small patches of cropland and used the woodlands and forests for open-range cattle and hog raising. They also burned the land. Valleys of the White River area were well occupied by time of the Civil War, but Douglas and Ozark Counties were still being occupied after the war. Early settlement was by old-stock Americans, chiefly people of Scotch-Irish ancestry coming from southern Appalachia. Rural population reached its peak around 1920 after which decline set in due to changes in the agricultural economy. Many creek-bottom farms have been given up and replaced by homes along ridge roads occupied by people who work in nearby towns and cities. Recreation and retirement population around the lakes has grown rapidly by immigration in the last few decades of the twentieth century. Away from the lakes, population also has begun to grow, but at a slower rate.

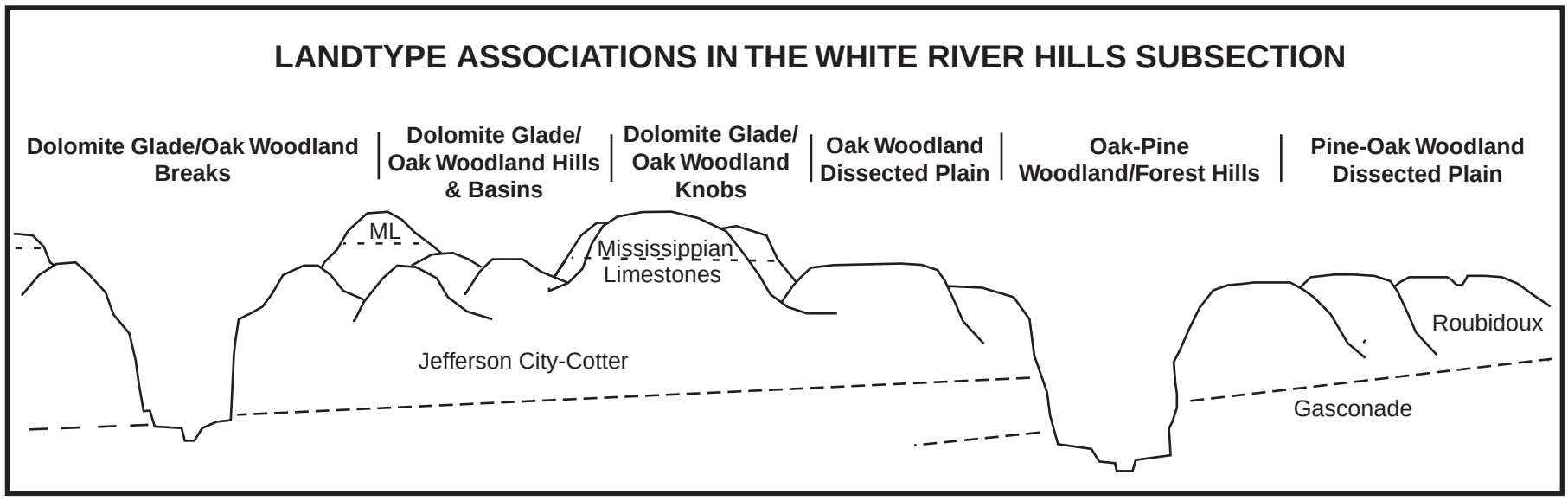
Economics and Land Use. The Civil War greatly disrupted early settlement and the economy. Many farms had to be reoccupied and recleared. Fencing and fire control caused many naturally open lands to grow up in brush or small trees. Fire suppression in the glade country probably enhanced the growth of cedars and other trees. Large-scale lumbering took place after the turn of the century in some parts. For the White River Hills Subsection as a whole, forests and woodlands dominate. Cleared lands for pasture are important in Douglas and Ozark Counties. Cropland is very limited, occurring primarily in stream bottoms. Commercial and residential land use is widespread around Table Rock Lake, Lake Taneycomo, and Bull Shoals Lake, and centers on Branson. Tourism began early in the twentieth century after the construction of Ozark Beach Dam formed Lake Taneycomo in 1912 and railroads provided access to it. Recreation and tourism have developed enormously in the last third of the century, especially around Branson and the large lakes on the White River. Most of the cropland has been abandoned, but cattle raising, both beef and dairy, has grown in importance, especially in the eastern half of the region. Commercial activity is vigorous around Table Rock Lake and Lake Taneycomo, and retirement communities have developed there also.

LANDTYPE ASSOCIATIONS

The White River Hills Subsection is subdivided into seventeen landtype associations (LTAs). They range from high, gently rolling oak savanna/woodland dissected plains, through rugged dolomite knobs and river breaks, to more typical oak-pine woodland/forest hills. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

While some efforts have been successfully undertaken on public lands, restoration of the dolomite glade and woodland complexes unique to this ecoregion is a principal challenge. Integrating grazing and wood utilization with restoration activities may increase the economic value of the lands. Careful use of prescribed fire is essential. Widespread development around the region's lakes threatens water quality and causes habitat fragmentation. Identification and conservation of key landscapes and watersheds will contribute to the long-term conservation of the esthetics of the natural environment that are chiefly responsible for attracting people to the region.



(see landtype associations map pg. 158–159)

LANDTYPE ASSOCIATIONS IN THE WHITE RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ4a White River Dolomite Glade/ Oak Woodland Rugged Hills and Knobs	The LTA is composed of hills and knobs surrounding Table Rock Lake and the lower James River. Most boundaries are where the Springfield Plain breaks off to the steeper topography of this region. Other boundaries, with the lower-relief Jenkins and Shell Knob basins and Forsyth plain, are based on a reduction of relief. Bull Creek Breaks, quite similar to this LTA, constitutes its own LTA because of its near geographic separation along Bull Creek upstream from Taneycomo.	A very rugged region of bald knobs and extended ridges. High, sinuous ridges are capped with cherty Mississippian limestone residuum that changes into steep, often abrupt sideslopes on Jefferson City–Cotter dolomite. Local relief is 250–600 feet or more. Dolomite glade/woodland complexes are common; many glades are currently dense cedar thickets. Intervening valleys are well timbered, occasionally in rare, rich limestone-dolomite forest communities. Rare and endemic species associated with the glades and adjacent habitats are abundant in this LTA. Land use in the James River basin includes pasture and some cropland. Development in the Table Rock Lake and Branson areas is growing with ever-expanding impacts. The LTA includes substantial amounts of USDA Forest Service land and Roaring River State Park.
OZ4b Shell Knob Dolomite Glade/ Oak Woodland Basin	This LTA occupies a basin of unusually low relief at the western end of Table Rock Lake in the vicinity of Shell Knob. Boundaries are drawn based on less than 150 feet of local relief.	The topography consists of a smooth to strongly rolling landscape with occasional, isolated knobs rising to higher elevations (e.g., Shell Knob and Turkey Knob) and bold lakeside cliffs. Most areas of gentler topography are in pasture. The more hilly areas have glade/woodland complexes and dense second-growth timber. Most of the land is in private ownership and heavily influenced by recreational activities.
OZ4c Bull Creek Dolomite Glade/ Oak Woodland Breaks	The LTA consists of rugged hills along Bull Creek. Northern and western boundaries are the crest of the pronounced Burlington Escarpment that marks the edge of the Springfield Plain. The northeastern boundary is the watershed divide with upper Swan Creek. Southeastern and southern boundaries are based on the change to a dissected plain of lower relief.	High Mississippian limestone ridges give way abruptly to steep slopes cut into the Jefferson City–Cotter dolomite with frequent rock ledges. Glade/woodland complexes formerly were common on these slopes with thin soils, but most are dense cedar thickets today. Cleared pasture occupies the rounded uplands on the western side and most alluvial plains. The balance of lands is in dense second-growth oak timber. The LTA includes substantial USDA Forest Service lands and the Busiek Conservation Area.
OZ4d White River Dolomite Glade/ Oak Woodland Breaks	This LTA occupies the entrenched, inner valley of the White River from near Swan Creek to the Arkansas state line. The valley is now occupied by Lake Taneycomo and Bull Shoals Lake. Boundaries are drawn to separate these steeply sloping lands with very high local relief from the surrounding lower-relief hills.	Bold cliffs, narrow ridges, and deep valleys, partly submerged, characterize the LTA. Unique cliff-top glades are common. Most ravines are timbered, but some ridges and unsubmerged valley bottoms are cleared pasture. Development pressures are intense around Forsyth.
OZ4e Forsyth Oak Woodland Dissected Plain	This LTA consists of strongly dissected land along the Taneycomo portion of the White River valley and extending into the lower reaches of Swan Creek. Knobs and glades are much less characteristic of this LTA than landscapes to the west and east. Boundaries are drawn to separate this LTA from LTAs of even higher relief to the east and west.	A landscape of broad, gentle uplands giving way to steep hills and narrow valleys underlain by Jefferson City–Cotter dolomite and lacking the Mississippian-capped knobs and ridges of surrounding areas. Historically oak woodlands on the hills graded into glade/woodland complexes near the valleys. Today, the area is principally pasture with some overgrown glades and densely timbered areas on the roughest lands, near streams. Development pressures are very intense around Branson and Forsyth and cause concern for water pollution, enhanced erosion, and loss of habitat.

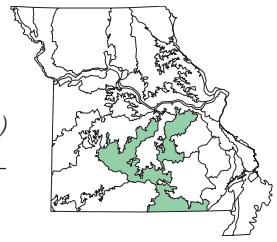
LANDTYPE ASSOCIATIONS IN THE WHITE RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ4f Little North Fork Dolomite Glade/Oak Woodland Hills	The LTA includes the hills associated with the submerged portion of Little North Fork River and its tributaries. Boundaries approximate a gradual transition from the higher relief of this LTA to the lower-relief hills farther up the valleys.	Rather broad ridges give way to steep slopes flanking the valleys in a landscape of over 250 feet of local relief. The whole landscape is underlain by Jefferson City–Cotter dolomites. Shallow soils support glade/woodland complexes on sideslopes, while deeper soils are mainly timbered in second-growth oak forest. More gently sloping uplands are mainly pasture. The Theodosia arm of Bull Shoals Lake is in the center of this unit.
OZ4g Upper Swan Creek Dolomite Glade/Oak Forest Breaks	The LTA consists of rugged lands in the upper reaches of Swan Creek. The northern boundary is the Burlington Escarpment, a very sharp break in topography and lithology with the Springfield Plain. The eastern and southern boundary separate this unit from noticeably lower relief. The western boundary is the watershed divide with Bull Creek.	The landscape consists of very rugged lands associated with the high-gradient headwaters of Swan Creek. Narrow, rocky ridges of cherty Mississippian limestone residuum give way to steep slopes of narrow, sinuous valleys cut into the Jefferson City–Cotter dolomites. Shallow to moderately deep, glade/woodland soils occupy most sideslopes and are complemented by deep, cherty soils in deep ravines that support more timber. Ridges and valley bottoms are mainly in cleared pasture. The LTA includes substantial acreages of USDA Forest Service land.
OZ4h Gainesville Dolomite Glade/Oak Woodland Knobs	Known locally as the "Caney Hills," this LTA is a collection of prominent knobs and extended ridges that project above the surrounding plains just north of Gainesville. Boundaries are drawn to encompass the knobs and associated high elevations and relief.	This LTA is an isolated series of elevated knobs and extended ridges, far separated from the larger region of knobs in Taney County, that forms a rugged landscape that stands out conspicuously from all surrounding regions. The knobs are capped in a thin layer of cherty Mississippian limestone residuum. Sideslopes and extended ridges have shallow, glade/woodland soils. Deeper soils support denser timber. Model glade/woodland restoration is being undertaken at Caney Mountain Conservation Area.
OZ4i Hercules Dolomite Glade/Oak Woodland Knobs	This LTA is a large rugged area of elevated knobs and extended ridges associated mainly with Beaver Creek and its tributaries in northeastern Taney County. Boundaries are drawn to encompass the knobs and associated high elevation and relief.	A large rugged area of elevated knobs and long ridges with caps of cherty Mississippian limestone residuum and characteristic dolomite glade/woodland balds. Some of the largest glade complexes in the state occur here. Intervening valleys are mainly timbered in mixed-oak forest, but broader valley bottoms are cleared pasture. The LTA includes the Hercules Glades Wilderness and the Gladetop Trail. Most of the area is owned by the USDA Forest Service.
OZ4j Ava Oak Woodland Dissected Plain	The LTA is a moderately dissected plain associated with the upper Beaver Creek drainage in western Douglas County. Boundaries circumscribe a dissected plain of low relief with more rugged areas surrounding it.	Gently rolling uplands give way gradually to broad, undulating valleys. Relief near the deeper valleys can be as high as 250 feet, but in most of the area it is less than 150 feet and thus one of the lowest-relief LTAs of the White River Hills Subsection. Underlain exclusively by the Jefferson City–Cotter Formation, it has characteristically cherty soils. Historically a landscape of oak savanna and woodland, today most of it is pasture with small, isolated patches of dense second-growth oak woodland. Little of the land is in public ownership.
OZ4k Gainesville Oak Woodland Hills	The LTA is a large, arch-shaped area comprising most of the headwaters of the Little North Fork River in Ozark and Taney Counties and the land along Norfolk Lake in southeastern Taney County. Boundaries are drawn to separate these lands of moderate relief from more steeply sloping and dissected hills on almost all sides.	The LTA consists mainly of broad, rolling hills and wide, undulating valleys with as much as 200 feet of local relief. Residual soils developed on Jefferson City–Cotter dolomite are moderately deep to deep. Historically dominated by oak woodland, the landscape today is chiefly pasture and large blocks of second-growth oak forest. A few isolated knobs harbor glade/woodland complexes. The LTA includes small blocks of USDA Forest Service land and Army Corps of Engineers land at Norfork Lake.
OZ4l Romance Oak Woodland Dissected Plain	This small LTA is a gently rolling divide between Bryant Creek and Little North Fork River in north-central Ozark County. Boundaries are drawn to encompass the small upland area of low relief.	The LTA occupies a drainage divide of less than 150 feet of relief. It has droughty soils on Jefferson City–Cotter dolomite and was historically an oak savanna and woodland. Today it is mostly pasture with small tracts of dense forest.

(table continued on pg. 102)

LANDTYPE ASSOCIATIONS IN THE WHITE RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ4m Bryant Creek Oak-Pine Woodland/Forest Hills	The LTA consists of deeply dissected lands traversed by Bryant Creek in Douglas and Ozark Counties. Boundaries are drawn where the greater relief of this LTA merges into the lower relief of surrounding LTAs; the line is generally drawn at 250 feet of local relief. The northern boundary is the drainage divide between White River and Gasconade River drainages.	Broad ridges on Jefferson City–Cotter and Roubidoux Formations give way to steep slopes of narrow, sinuous valleys cut into the Gasconade Formation. Local relief is 200–350 feet. Valleys are lined with low cliffs. Karst is prominent is several places; caves, springs, and losing streams are common. Historically, pine-oak woodland occupied the higher elevations in the landscape and graded into oak-pine and mixed-oak forest in the deep valleys. Today, dense second-growth oak forest is the dominant land cover with scattered pine plantations. Overgrown glade openings line some cliff tops and exposed slopes. Many broad ridges and valley bottoms have cleared pasture. The LTA has very little public land.
OZ4n Van Zant Oak Woodland Dissected Plain	The LTA consists of the large rolling upland divide between Bryant Creek and the North Fork River in eastern Douglas County. Boundaries are drawn at about 150 feet of relief to separate this LTA from the surrounding higher-relief hills. The northern boundary is the drainage divide between the White River and Gasconade River basins.	This LTA is a large, broad upland divide with smooth to strongly rolling topography, much of it the product of solution of underlying carbonate rock. This is one of the lowest-relief LTAs of the White River Hills Subsection. Smoother areas are associated with the Jefferson City–Cotter Formation, which gives way to the Roubidoux at lower, steeper slopes. Karst landscapes occur locally. Historically, the LTA had a land cover of oak savanna and woodland with occasional prairie openings. Today it is mainly pasture with large, isolated tracts of dense second-growth forest. Public lands are limited.
OZ4o North Fork River Oak-Pine Woodland/Forest Hills	The LTA consists of the deeply dissected lands traversed by the North Fork River in eastern Douglas and Ozark Counties. Boundaries are drawn to separate the greater relief of this LTA from surrounding LTAs with less relief; the line is generally drawn at 250 feet. The northern boundary is the Ozark Divide that separates south- and north-slope Ozark drainage basins.	Broad ridges on Jefferson City–Cotter and Roubidoux Formations give way to steep slopes of narrow, sinuous valleys cut into the Gasconade Formation. Local relief is 200–350 feet. Valleys are lined with low cliffs; many seep-fed moist cliffs support rare species. Karst is common, including caves, springs, and losing streams. Historically, pine-oak woodland occupied high elevations in the landscape and graded into oak-pine and mixed-oak forest in deep valleys. Today, dense second-growth oak forest is the dominant land cover, with scattered pine plantations. Overgrown glade openings line some cliff tops and exposed slopes. Many smooth ridges and valley bottoms are in cleared pasture. The LTA includes large acreages of USDA Forest Service land. Numerous rare species sites are associated with the North Fork River and adjacent habitats.
OZ4p North Fork Pine-Oak Woodland Dissected Plain	This LTA is a narrow, dissected plain along the eastern edge of the North Fork River basin. Boundaries are drawn specifically to encompass the dissected plain on Roubidoux sandstone with shortleaf pine. The LTA is generally transitional in relief between the lower-relief Central Plateau Subsection to the east and the higher-relief hills along the North Fork River to the west.	The LTA is a moderately dissected plain of 150–250 feet of relief that both historically and currently supports shortleaf pine and pine-oak woodland. It has a nearly even mix of large patches of pasture interspersed with pine and oak-pine forest. Some of the pine has been planted. The LTA includes large acreages of USDA Forest Service land associated with timberlands.
OZ4q Jenkins Oak Savanna/ Woodland Basin	This LTA is an unusually smooth to moderately dissected basin associated with Flat Creek in Barry County in the northwestern corner of the ecoregion. All boundaries but the southeastern one are defined as the transition, quite conspicuous in the landscape, to the much less dissected plain of the Springfield Plateau Subsection. The southeastern boundary leads into much more deeply dissected land closer to the White River.	This lower-relief basin is almost completely encircled by higher, smoother lands. Underlain by Mississippian carbonate formations, it has numerous springs and deep cherty soils. The LTA lacks the knobs and glades that characterize much of the rest of the western parts of the White River Hills Subsection. It was historically oak savanna; now, it is primarily pasture with oak forest on steeper slopes. It has no public lands.

OZ5
CENTRAL PLATEAU SUBSECTION

(see map pgs. 160–165)



GENERAL DESCRIPTION

The subsection consists of some of the least dissected portions of the Ozark Highlands and therefore a portion that retains the semblance of a true plateau surface. Dominated by carbonate lithology, it is strongly karstic in many portions and is mantled by a very thick solution residuum. Lack of surface water and droughty soils are characteristics. Presettlement vegetation was mostly savanna or grassy woodland, and prairie, especially in western portions. Much of the land has been cleared for pasture although trees and brush dominate locally.

LOCATION AND BOUNDARIES

This octopus-shaped subsection lies in the central, western, and southern Ozarks and comprises portions of no fewer than twenty-six counties but centers on Dallas, Laclede, Webster, Wright, Texas, Dent, Howell, and Oregon Counties. It lies along the crest of the Ozarks and extends along the major watershed divides that radiate outward on both the northern and southern slopes of the Ozark Highlands. In general, its boundaries are drawn where the typically low relief of the plateau becomes greater than 150 feet along the edges of the surrounding drainage systems (Osage, Gasconade, Meramec, Current, and White). In places, as in Crawford, Maries, and southern Wright Counties, the break with the river hills is very sharp and unmistakable in the landscape, but in most places it is a more gradual transition to greater dissection of the land surface. The boundary in the southwest with the Springfield Plain is the Burlington Escarpment, a conspicuous rise of 100–200 feet in elevation to the higher Springfield surface. The short boundary in the southeast with the Black River Ozark Border Subsection is drawn where loess soils become characteristic. Similarly, the boundary in the extreme north with the Inner Ozark Border in Osage, Gasconade, and Franklin Counties is drawn where loess becomes a significant characteristic of the upland surface. The subsection extends into north-central Arkansas.

CLIMATE

Mean annual precipitation ranges from 40 inches in the north to 48 inches in the southeast. The wettest months are March–June and the six warmer months of the year account for 56 percent of the annual precipitation (at Mountain Grove). Annual snowfall ranges from 18 inches in the north to 10 inches in the south. Mean January minimum daily temperature is 18° in the north and 21° in the south. Mean July maximum daily temperature is approximately 90° throughout the subsection, but somewhat lower in higher elevations. The growing season averages 205–210 days. Significant microclimatic variations occur in the more dissected areas and in deep sinkholes.

TOPOGRAPHY AND GEOLOGY

The Central Plateau occupies the higher, minimally dissected parts of the Ozark Highland. The plateau is an irregular plain with a local relief of 50–150 feet. Because of differential solution of the rock mass, the surface is hardly anywhere flat. Most slopes are very gentle, but they steepen where major drainage lines are approached. Geologic strata are essentially horizontally bedded. Although the strata regionally dip slightly northward and southward from the topographic crest of the Ozark uplift (also the Ozark regional drainage divide), they appear to be essentially horizontally bedded in most localities. Formations are virtually everywhere thick, cherty dolomites with some prominent sandstones, all of Ordovician age. Most prominent are the Jefferson City–Cotter dolomites that underlie higher elevations and the Roubidoux dolomites and sandstones that underlie the lower elevations. The sandstones often form ledges on hillsides. Pennsylvanian shales occur in the extreme north.

Most of the upland surface shows the effects of severe, pervasive, and long-enduring solution of the carbonate bedrock. In places, the surface has been lowered scores of feet by solution, leaving behind a very thick, uneven residuum with rock fragments, mostly insoluble chert. Surficial materials are characteristically naturally rocky and have been made more so by human-induced erosion of fines following clearing of the land. The upland surface contains large, shallow solutional basins (pans), dry valleys, and numerous tracts of sinkholes. Fines washed into swales and low places create places with poor surface drainage. Large, well-developed karst tracts are around West Plains (Howell and Oregon Counties), Lebanon (Laclede and Camden Counties), and Salem (Dent County). The surface karst of the Central Plateau is one of the chief sources for groundwater that resurfaces in the numerous large springs of the surrounding entrenched-river subsections. The westernmost portions of the subsection are less karstic and contain prominent, isolated hill outliers of the Burlington Escarpment (Polk and Greene Counties). Several isolated hills (monadnocks) rise conspicuously above the general surface along the regional Ozark Divide in Wright and Texas Counties.

SOILS

Most of the soils in this subsection were weathered from the underlying Ordovician dolomite, with a thin veneer of silty loess. Fragipans are widespread in the subsoil on the gently rolling plateau surface, and fragipan soils such as Gepp, Viraton, Ocie, and Wilderness are common. The fragipans restrict root development and are responsible for the squat, gnarly appearance of trees on these soils. Backslopes are dominantly deep soils with red cherty subsoils such as Clarksville and Noark, as well as the moderately deep Gatewood soils. Shallow soils in glades are relatively uncommon in this subsection. Floodplains are narrow and not extensive, with very gravelly soils such as the Cedargap series.

HYDROLOGY

This subsection spreads out along upland drainage divides and therefore is not associated with any particular drainage basin; it contains the headwaters of most Ozark drainage systems. Because it lies on upland drainage divides with surface karst, almost all of the streams are intermittent (seasonal) or ephemeral (flowing only after runoff from rains). The largest streams are the Bourbeuse, Maries, and Pomme de Terre on the north side, and lower portions of the perennial Eleven Point and Current on the south side. Widespread karst conditions inhibit the development of surface streams. Drainage density (in number of miles of stream channel per square mile) is very much lower in the Central Plateau than in all adjacent river-hills subsections, and thus surface water is generally less available in this region than would be expected from its relatively abundant precipitation. Stream gradients are low to moderate in the headwaters. Channels are in a mixture of silts and gravels. Streamflow is highest in late winter and spring when water tables are highest and seepage and spring flow greatest, and may dwindle to near zero surface flow during late-summer dry spells, leaving water only in pools. Flash floods may last for a few hours on these small streams. Only small springs are common in this low-relief landscape. Natural standing water is lacking, except for sinkhole ponds and marshes. Thousands of ponds and small lakes have been constructed for stock watering and local water supplies. Stream water quality varies according to agricultural runoff and runoff from built-up areas. Subsurface water is abundant and of high quality, except for "hardness." The subsection is a major source area for groundwater that emerges in springs in the entrenched stream valleys on its sides.

The Central Plateau Subsection was once covered in a diverse mosaic of prairie, savanna, and open oak woodlands. Today it is largely pasture and dense second growth timber.

Tim Nigh

TERRESTRIAL NATURAL COMMUNITIES

Historic. The Central Plateau Subsection was formerly dominated by a mosaic of tallgrass prairie and oak savanna/woodland (dolomite, chert, and sandstone) communities. Henry Rowe Schoolcraft referred to them in the early nineteenth century as "high oak prairies." These gently rolling uplands were subject to repeated soil drought and frequent fires that restricted the development of forest communities. Post, blackjack, and black oaks were the dominant woodland trees, and bluestem grasses the dominant herbaceous ground cover. Sinkhole ponds supported a unique flora.

Current. Very little of the historic vegetation, both prairie and dense woodland, remains. Most of this landscape has been converted to fescue pasture, oak woodlots, and a modicum of cropland. Areas of abandoned, eroded farmland that were acquired as part of Mark Twain National Forest were widely planted to shortleaf pine by the CCC beginning in the 1930s. Rougher hillslopes have become more closed oak forests under fire exclusion and timber management. Savanna and flatwoods restoration projects are underway on national forest and other conservation lands.

Major Natural Community Types

Midwest Dry-Mesic Chert Prairie

Post Oak Flatwoods

Central Post Oak Dry Barrens (Savanna)

Post Oak–Blackjack Oak/Bluestem Dry Chert or Sandstone Woodland

Post Oak, Black Oak, Scarlet Oak Dry Chert or Sandstone Woodland

Rare or Restricted Natural Communities. Outstanding examples of Ozark prairie, oak woodlands, and upland flatwoods, once common to the region, are very rare or unknown at present. Fewer than 20 sites have been documented. Only approximately 20 quality sinkhole pond and flatwood communities have been identified. Only a few sites provide examples of rare dolomite glade, fen, and headwater stream communities.

NATURAL DISTURBANCES

Drought and subsequent fire were keys to the creation and maintenance of this prairie and woodland mosaic. Grazing by deer, elk and bison, and the effects of wind and ice storms, also added to the mosaic.

RARE OR ENDANGERED SPECIES

The subsection contains 295 records of 119 state-listed species. Nine of the species are known only from this subsection in Missouri. Habitats supporting an exceptional number of rare and range-restricted species include upland prairie, upland savanna and woodland, and streams. Despite its high and dry nature, a substantial number of rare species are associated with the headwater streams and creeks of the Central Plateau. These include federally listed gray and Indiana bats *(Myotis grisescens* and *M. sodalis)* and the Niangua darter *(Etheostoma nianguae),* as well as numerous other darters, minnows, and mussels. Mead's milkweed *(Asclepias meadii)* is another federally listed species known from the ecoregion.

NATURAL AREAS

Although there are ten Natural Areas that extend into the ecoregion, many of the distinctive features of the Central Plateau are poorly represented in them. Oak flatwoods are represented only at Quercus Flatwoods. The only prairie is at La Petite Gemme Prairie. Karst features are in Grand Gulf. Unique cliffs, seeps, and springs occur at Piney River Narrows, Dripping Springs, Mint Spring Seep, and Carman Springs. Glade-woodland complexes occur at Solomon Hollow and Bald Hill Glades. An upland forest is in Hyer Woods.

PUBLIC LANDS

More than 110,000 acres of public conservation lands are in the Central Plateau Subsection, a relatively low number relative to its size and extent. Most of the acreage is managed by the Mark Twain National Forest (more than 70,000 acres) or the Missouri Department of Conservation (more than 30,000 acres). Only three state parks touch the ecoregion.

HUMAN GEOGRAPHY

Demographics. Osage and other Indian settlement consisted primarily of scattered

Richard Thom

Stunted post, blackjack, and black oak would have been common in the barrens of the Central Plateau Subsection.

temporary camps for hunting. The first American occupation was also for hunting and included extensive burning of woodlands and grasslands. Because it was deficient in surface water and even in timber in many places and difficult of access from navigable rivers, the Central Plateau in general was unattractive to early American agricultural settlement, although early settlers in the adjacent river valleys grazed their animals on the grasslands of the Central Plateau. Parts of the subsection (especially Howell County and the Ozark Divide) were among the last parts of the Ozarks to be settled agriculturally. Settlement basically took place in the 1830s through the 1880s, although the more accessible parts like Gasconade and Franklin Counties in the north and Polk and Dallas Counties in the west were filled in somewhat earlier. Settlers, some with slaves, came from a great variety of source regions, but Tennessee and Appalachia dominated.

Economics and Land Use. Until well into the twentieth century, the rural economy was based on small patches of cultivated crops (primarily corn and oats) and livestock (especially cattle and hogs). Woodlands and natural prairies were used for grazing. Cessation of uncontrolled fires, made necessary when farms were extended onto the grassy uplands, was largely responsible for much of the former grasslands changing into brush, scattered trees, or woodland. Soils eroded readily when broken for crops. Fruit growing was attempted in the early twentieth century. At the middle twentieth century, farming changed. Submarginal farms were abandoned and farms became larger and more commercial. Croplands rapidly declined in acreage, and improved pasturelands of nonnative grasses greatly increased. Open-range grazing was eliminated. On the better soils, land was increasingly cleared of brush and trees for use as pasture. Currently, specialized farming includes grapes in Crawford and Phelps Counties and poultry raising in several counties. Counties near Springfield concentrate on dairy cattle. Beef cattle are raised throughout the region. Other economic activities include a vigorous service industry oriented to recreation and tourism along the I-44 corridor and locally elsewhere. Small-scale industry has been established in the subsection's small towns: Lebanon, Bolivar, West Plains, Salem, Rolla, Sullivan, and others. Charcoal-making is a distinctive forest-product industry.

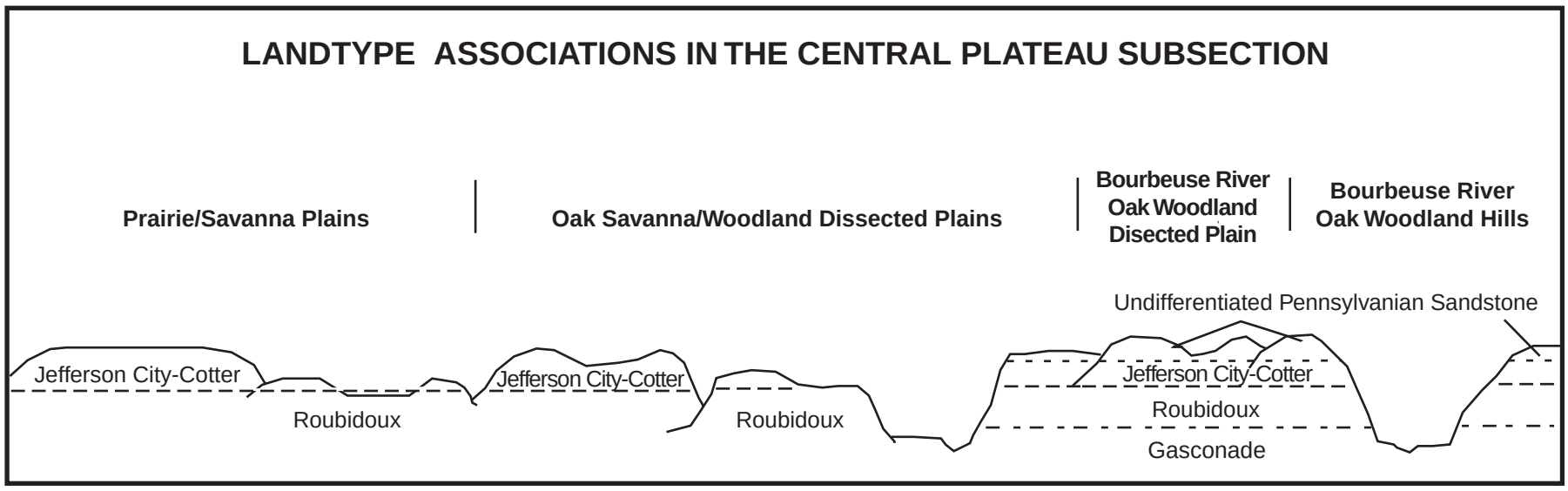
LANDTYPE ASSOCIATIONS

The Central Plateau Subsection is divided into thirty landtype associations (LTAs). The LTAs can be grouped into three general types: 1) Prairie/Savanna Plains are high, smooth landscapes that were formerly dominated by prairie and open-oak savanna and are mainly associated with the highest drainage divides in the upper Osage River basin. 2) Oak Savanna/Woodland Dissected Plains are high, minimally dissected areas in the eastern part of the region that had historic oak savanna and prairie openings interspersed with oak woodland. 3) Oak Woodland Dissected Plains and Hills occupy the most thoroughly dissected parts of the ecoregion, with up to 150 feet of local relief; they were formerly dominated by a nearly continuous cover of open-oak woodland. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

Of the Ozark Highlands subsections, the Central Plateau is one of the most severely affected by human settlement and use. Many roads, towns, and farms are located on this relativley smooth surface. Native grasslands, savannas, and woodlands have been converted to nonnative pasture or cut over and allowed to grow up in dense timber in the absence of fire. Though the current mosaic of grass and timber is somewhat similar to historic, few high-quality examples of these terrestrial ecosystems remain. Stream systems have also been affected, but they offer substantial opportunity to conserve rare fish species like the Niangua darter. Conservation activities will require ecosystem restoration on a large scale. Restoration of the native grassland/woodland mosaic might not only benefit native plant and animal species, but could also provide forage and timber resources and enhance watershed protection and tourism.

LANDTYPE ASSOCIATIONS IN THE CENTRAL PLATEAU SUBSECTION



(see landtype associations map pgs. 160–165)

LANDTYPE ASSOCIATIONS IN THE CENTRAL PLATEAU SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ5a Bolivar Prairie/Savanna Plain	This small LTA occupies a drainage divide at Bolivar in Polk County. The western boundary rises to somewhat higher ground of the Springfield Plateau. The eastern boundary is drawn where relief becomes greater than 75 feet.	The LTA is a flat plain of less than 75 feet of local relief on the divide between the Little Sac and Pomme de Terre Rivers on the eastern side of the Burlington (or Eureka Springs) Escarpment. Several conspicuous isolated mounds, outliers of the escarpment, rise above the plain. The plain is constructed on Jefferson City–Cotter dolomite with a thin layer of loess. Historically about 50 percent prairie, the LTA today is mostly in fescue pasture and woodlots. La Petite Gemme Prairie Natural Area is located here.
OZ5b Upper Pomme de Terre Oak Savanna/Woodland Dissected Plain	This LTA comprises the portions of the Pomme de Terre River basin above Pomme de Terre Lake, mostly in Polk County. The western boundary is the distinct topographic rise at the Burlington Escarpment with the exception of the Bolivar Plain. The northeastern boundary is drawn where relief declines to the Buffalo Plain. The southeastern boundary is the watershed divide with the Niangua River basin.	The LTA consists of moderately rolling hills of relief generally less than 150 feet but with small areas of greater relief adjacent to larger valleys. It is mainly underlain by Jefferson City–Cotter dolomite with isolated ridges and mounds capped with Mississippian limestone; some of these are very conspicuous, such as those at Fair Grove in northeastern Greene County. Deep, cherty, silt loam soils are common. Historically, the ecoregion was prairie on the smoothest areas, which graded into post oak savanna, then mixed-oak woodland in the rougher areas. Today, the region is mainly fescue pasture and isolated woodlots.
OZ5c Buffalo Prairie/Savanna Plain	The LTA occupies the long, narrow, and flat divide between the upper Pomme de Terre and Niangua River basins in Hickory, Dallas, and Polk Counties. US 65 traverses the length of this plain for 40 miles. Boundaries are drawn to encompass the plain with less than 75 feet of local relief.	The LTA is a plain of less than 75 feet of local relief with a thin layer of loess over Jefferson City–Cotter dolomite. Fragipan soils are common. Historically, mostly 50 percent prairie with arms of timber along drainageways, it is now mostly in fescue pastures and isolated woodlots.
OZ5d Upper Niangua Oak Savanna/ Woodland Dissected Plain	This large LTA occupies the rolling topography associated with the uppermost reaches of the Niangua and Little Niangua Rivers, encompassing most of Dallas County and northwestern Webster County. The northwestern boundary is based on the much lower relief of the Buffalo Plain, while the southwestern is the divide with the Pomme de Terre River. The short southern boundary is the prominent Burlington Escarpment south of Mansfield. The far southeastern boundary is the watershed divide with the Osage Fork. The eastern boundary is placed where relief declines to the Lebanon Plain. The northeastern and northern boundaries approximate the increase in relief to over 150 feet in the Niangua Hills.	The LTA consists of gently to moderately rolling hills associated with the upper Niangua River basin. Local relief is generally less than 150 feet, with small areas of greater relief adjacent to the valleys and very low relief on drainage divides. The ecoregion is mainly underlain by Jefferson City–Cotter dolomite except in the deepest valleys where the Roubidoux Formation occurs. Deep, cherty, silt loam soils are most common. Historically, the ecoregion had prairies on most upland areas, grading into post oak savanna, then mixed-oak woodland in the rougher areas. Today, the region is mainly fescue pasture and isolated woodlots. The LTA has significant Niangua and bluestripe darter populations and includes the Bennett Springs Savanna.

(table continued on pg. 106)

LANDTYPE ASSOCIATIONS IN THE CENTRAL PLATEAU SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ5e Upper Gasconade Oak Woodland Dissected Plain	A large, very irregularly shaped landscape constituted by the upland plain of slight dissection in the upper reaches of all the forks of the Gasconade River basin between Marshfield and Raymondville and the similar upland plain in the upper Eleven Point River basin. Boundaries are drawn generally to circumscribe the dissected plain with less than 150 feet of local relief, but excluding the flattest parts of drainage divides. In the northwest, the boundary is drawn where relief lessens on the Lebanon Plain. The southern boundary is the Ozark Divide (the divide with the White River Basin), except for several plains of low relief on broad drainage divides. The crenulated eastern and northern boundaries approximate a change of relief to more than 150 feet into the higher-relief hill LTAs of the Current and Gasconade River systems; generally this change brings steeper and more wooded slopes, rock outcrops, springs, and more substantial streamflow.	Broad uplands and ridges give way to gentle or moderately sloping areas with 50–150 feet of local relief, although areas near major streams can have up to 200 feet of relief. The region is underlain by Jefferson City–Cotter dolomite except for deeper valleys in transitional areas underlain by the Roubidoux Formation. Soils are mainly deep, cherty, silt loams with occasional restrictive clay layers; flattest areas have a loess cap and a fragipan. Historic vegetation was mainly mixed-oak woodland. Today, the region is fescue pasture and woodlots of varying size, but with more woodland in transitional areas. US 60 and US 63 traverse the region.
OZ5f Lebanon Prairie/Savanna Karst Plain	The LTA occupies the reasonably flat divide between the upper Osage Fork and Niangua River basins, running north and southwest of Lebanon mostly in Laclede County. Boundaries are drawn to enclose the plain with less than 100 feet of local relief. This boundary is rather abrupt on the east and west where it drops off into stream valleys, but on the north the watershed divide with the Auglaize Creek is used.	The LTA is the high, flat to slightly rolling plain with less than 100 feet of local relief. It has a thin loess cover on the flattest areas, with cherty residuum from the Roubidoux and Jefferson City–Cotter Formations throughout. Much of the irregular surface is more the result of differential solution processes than stream processes. Sinkholes, broad solution depressions, losing streams, and other surface karst features are common. Most streams are intermittent or ephemeral; Goodwin Hollow north of Lebanon is a primary example of a losing stream. The LTA provides groundwater for the springs in the Niangua, Auglaize, and Gasconade valleys. Fragipan soils are common beneath the loess, while deep, cherty, silt loams occupy most of the region. Historically, the ecoregion had scattered prairie on the smoothest and most karstic areas, grading into post oak savanna, then mixed-oak woodland in increasingly dissected areas. Today, the region is mainly fescue pasture and isolated woodlots and is experiencing development pressures along the I-44 corridor.
OZ5g Auglaize Prairie/Savanna Dissected Plain	The LTA consists of moderately dissected lands in the headwaters of Auglaize Creek mostly in southeastern Camden County. The northwestern boundary approximates a change to higher relief and predominance of the Gasconade Formation and associated soils. The other boundaries are drawn for convenience on drainage divides.	Gently rolling uplands give way to moderately sloping land in the headwaters of Auglaize Creek. Relief is less than 150 feet but rises to 200 feet along the Wet Glaize Creek. Much of the surface shows the influence of long-standing solutional processes and the LTA serves as a source region for springs in the Auglaize system. Uplands have droughty fragipan soils on loess over Jefferson City–Cotter dolomite. Sloping areas occur mainly in the Roubidoux and Gasconade Formations, where a mosaic of shallow and deep cherty soils occur. Prairies once occupied the smoothest areas, grading into oak savannas and ultimately mixed-oak woodlands with increasing relief. Today, fescue pasture and substantial second-growth oak woodlands predominate. Caves support rare cave-dwelling species.
OZ5h Tavern Creek Oak Savanna/ Woodland Dissected Plain	The LTA occupies the upper reaches of the Tavern and Maries drainage systems mostly in Maries and Miller Counties. The eastern boundary, except in the vicinity of Dixon, is the watershed divide with the Gasconade River and is everywhere along its length a very conspicuous escarpment followed by US 63 and MO 133. The southwestern boundary is the divide with the Auglaize Creek drainage. The northwestern boundary approximates the transition from this lower-relief plain to much more rugged lands along the Osage River.	The LTA is a moderately dissected plain with local relief mainly less than 150 feet but reaching more than 200 feet in major valleys. Broad upland ridges on Jefferson City–Cotter dolomite, lightly covered with loess, give way to moderately sloping valleys cut through the Roubidoux into the Gasconade Formation. Soils include droughty fragipan soils on uplands, shallow soils on dolomite, and deep, cherty silt loams. Historically a mosaic of oak savanna and woodland with occasional small prairie and glade openings, the area is now dominated by fescue pasture but has large amounts of second-growth oak woodland and occasional overgrown glades. Some rare fish are known from creeks of high quality.
OZ5i Dixon Prairie/Savanna Dissected Plain	The LTA is a small upland plain north of Dixon, primarily in Maries County. Boundaries are drawn to encompass the plain of low relief and associated Pennsylvanian formations. An abrupt escarpment dropping off to the Gasconade valley marks its southwestern boundary.	This small LTA is recognized as an upland plain underlain by an isolated occurrence of Pennsylvanian sandstone and very acidic residual soils. The center of the LTA was historically prairie, which likely graded into post oak savanna. Today it is an even mix of fescue pasture and overgrown oak woodland.

LANDTYPE ASSOCIATIONS IN THE CENTRAL PLATEAU SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ5j Linn Oak Woodland Dissected Plain	The LTA occupies a narrow upland divide between the lower Maries and Gasconade Rivers. Boundaries are drawn to encompass the lower relief of the divide and its underlying associated Pennsylvanian sandstones and acidic soils. US 63 and US 50 follow ridges in parts of the LTA near Freeburg and Linn.	The LTA is a high, narrow divide of low relief on Pennsylvanian sandstone. Soils are exceptionally acidic and drought prone. Historically, stunted oak woodland dominated; today, a mosaic of fescue pasture and dense second-growth oak woodland dominates.
OZ5k Upper Gasconade Oak Savanna/ Woodland Plain	The small LTA occupies the upland plain between the headwaters of the Osage Fork and Woods Fork of the Gasconade River. Boundaries are drawn to encompass the upland with relief of less than 100 feet and fragipan soils.	The LTA is a high, narrow upland divide with local relief less than 100 feet. Loess lies over Jefferson City–Cotter dolomite. Soils are droughty with fragipans, and consequently tree growth is stunted. Historically, the LTA was post oak barrens; today, it is mostly in fescue pasture.
OZ5l Cabool–Mountain Grove Oak Savanna/Woodland Plain	The LTA consists of two separate upland plains at the headwaters of the Gasconade River in the vicinity of Cabool, Mountain Grove, and Norwood. Boundaries are drawn to encompass the two tracts of low relief and fragipan soils. The southern boundary is the Ozark Divide that separates the Gasconade and White River drainage basins.	The two parts of this LTA occupy high drainage divides that are some of the highest elevations in the south-central Ozarks. Relief is not flat but is less than 100 feet, and the surface is underlain by Jefferson City–Cotter dolomite with a thin deposit of loess. Soils are droughty with fragipans; trees are stunted. Historically, the LTA was post oak barrens; today, it is mostly in fescue pasture with considerable second-growth oak woods. US 60 follows the upland divide and commercial activities along it heavily influence land use, especially near Mountain Grove and Cabool. It is similar in most respects to the Summersville Oak Savanna/Woodland Plain LTA on the north side of the Jack's Fork River.
OZ5m Summersville Oak Savanna/ Woodland Plain	The LTA consists of a broad, reasonably flat upland between the Jack's Fork River and Big Creek at Summersville in southeastern Texas County. Boundaries are drawn to encompass this landform with relief of less than 100 feet, fragipan soils, and Jefferson City–Cotter dolomite. It is separated from the LTA to the east by geology.	The LTA is a plain with relief of less than 100 feet and stands out starkly in a general region of rugged hills. It is underlain by Jefferson City–Cotter dolomite substrate with thin loess at the surface. Karst landscapes appear locally. Soils are droughty with fragipans; tree growth is stunted. Historically, the LTA was post oak barrens; today, fescue pasture dominates, with considerable second-growth oak woods. It is similar in most respects to the Mountain View Oak Savanna/ Woodland Plain on the south side of the Jack's Fork River.
OZ5n Mountain View Oak Savanna/ Woodland Plain	The LTA is a broad, flat divide between the Jack's Fork and Eleven Point Rivers, with Mountain View at its center. Boundaries are drawn to enclose a landform with relief of less than 100 feet, fragipan soils, and Jefferson City–Cotter dolomite. It is separated from the plain to its east by geology.	The LTA is a plain with relief of less than 100 feet. It is underlain by Jefferson City–Cotter dolomite substrate with thin loess at the surface. Soils are droughty with fragipans; tree growth is stunted. Historically, the LTA was post oak barrens; today, fescue pasture dominates with considerable second-growth oak woods. It is similar in most respects to the Summersville Oak Savanna/Woodland Plain LTA on the north side of the Jack's Fork River.
OZ5o West Plains Oak Savanna/ Woodland Plain	The LTA occupies a broad upland in Howell County between the basins of the Eleven Point, North Fork, and Spring Rivers, with West Plains at its center. Boundaries are drawn to define a landform with relief of less than 100 feet, fragipan soils, and Jefferson City–Cotter dolomite.	The LTA is an upland plain, very slightly dissected, with relief of less than 100 feet. It is underlain by Jefferson City–Cotter dolomite with a thin layer of loess above. Many tracts of well-developed karst are scattered across the plain. Soils are droughty with fragipans; tree growth is stunted. Historically, the LTA was post oak barrens; today, fescue pasture dominates with considerable scattered acreages of second-growth woods. Sinkhole ponds and seeps form rare communities. Population and economic growth exert development pressures at West Plains.
OZ5p Howell-Oregon Counties Oak Woodland Dissected Plain	The LTA occupies the moderately dissected upland surface in the southern half of Howell and Oregon Counties, where it is mostly associated with the upper reaches of the Spring River basin. Boundaries are drawn to approximate the transition (at 100 feet) to the lower-relief and more thoroughly karstic plain in central Howell County and the transition (at 150–200 feet) to the higher-relief hills to the east (Eleven Point drainage) and west (North Fork drainage). These boundaries are nowhere conspicuous in the landscape and appear as transitions. The Arkansas state line forms the southern boundary.	The LTA is a slightly to moderately dissected upland plain with local relief mainly between 100 and 150 feet, except near deeper valleys where relief of 200 feet occurs. Thin loess deposits occur on the flattest lands, but most of the LTA is underlain by cherty residuum from the Jefferson City–Cotter dolomite. Some isolated areas of Pennsylvanian sandstone materials occur. Karst landscapes are common; Grand Gulf State Park is one of the most spectacular karst expressions in Missouri. The LTA in general serves as a source region for groundwater that emerges in springs in neighboring deep valleys. Soils are variable, from droughty fragipan soils to deep cherty silt loams. Historically, the LTA was timbered in mixed-oak woodland with occasional prairie and savanna openings. Currently, it is a mosaic of extensive fescue pasture and dense oak woodlots. Occasional surface seeps and ponding form rare communities in this carbonate-dominated landscape.

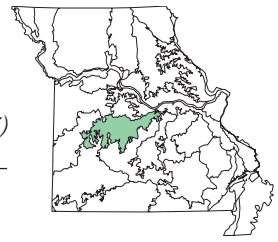
(table continued on pg. 108)

LANDTYPE ASSOCIATIONS IN THE CENTRAL PLATEAU SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ5q Alton Oak Savanna/ Woodland Plain	The LTA occupies a small upland plain between Alton and the Eleven Point River in central Oregon County. Boundaries are drawn to enclose a plain of less than 100 feet of local relief.	The LTA is a plain of low relief with loess over Jefferson City–Cotter dolomite. The plain is thoroughly karstic and lacks perennial surface water. Droughty fragipan soils stunt tree height. It was formerly post oak barrens, but today it is mainly fescue pasture.
OZ5r Ripley County Oak Woodland Dissected Plain	The LTA is a dissected plain lying mostly in southwestern Ripley County from the western side of the lower Eleven Point to the eastern side of the Lower Current River. The northern boundary marks a change to hills of noticeably higher relief. The eastern and western boundaries are changes to areas of lower relief and less timber. The southern boundary is the Arkansas state line.	The LTA is mostly a dissected plain of variable topographic expression from smooth uplands in headwaters of Fourche Creek to moderately and steeply sloping lands along the lower Eleven Point and Current Rivers. Also included is a distinctive long ridge with elevated knobs. Stream downcutting is limited by the close proximity of the base-level control of the Mississippi Alluvial Plain. The LTA is underlain principally by Jefferson City–Cotter dolomite with local expressions of karst. Soils vary from deep, cherty silt loams to shallow soils over dolomite bedrock. The region was formerly mixed-oak woodland with occasional glade and savanna openings. Today it is a nearly even mix of fescue pasture and dense mixed-oak forest. Several significant dolomite glade/woodland complexes occur. The LTA has experienced very little commercial development.
OZ5s Flatwoods Oak Savanna/ Woodland Plain	The LTA occupies a small upland in central Ripley County between the lower Current River and the Little Black River. Boundaries enclose a plain of local relief less than 75 feet associated with Jefferson City–Cotter dolomite. The western boundary breaks off sharply to the Current River.	The LTA consists of a flat upland with thin loess over Jefferson City–Cotter dolomite. Streams are intermittent or ephemeral and lose surface flow into coarse bed sediments. Fragipan soils are common. The LTA was formerly post oak flatwoods but today is chiefly a mixture of fescue pasture and dense oak forest. Very little nonrural development has occurred.
OZ5t Licking Oak Savanna/ Woodland Plain	The LTA occupies a long narrow divide that connects Raymondville, Licking, and Edgar Springs in Texas and Phelps Counties east of the Big Piney River basin. Boundaries are drawn to encompass the plain with local relief less than 100 feet. The boundaries are more distinct in the south and more transitional in the north.	The LTA consists of a flat upland plain with a thin loess cap over Jefferson City–Cotter dolomite in the south and Roubidoux sandstone in the north. Fragipan soils dominate and cause a timber cover of short, stunted post oaks. Historically the LTA was open post oak barrens with small prairie openings; today it is mainly fescue pasture.
OZ5u Big Piney Oak Woodland Dissected Plain	The LTA is small area located east of the Big Piney River in the headwaters of Spring Creek. The western boundary is drawn to distinguish it from steeper hills and pine woodland areas on deep ultisols and on lower Spring Creek. On the east the boundary approximates the transition to a low-relief plain.	The LTA consists of a small, dissected plain with local relief less than 150 feet, except near the major valleys where it increases to 200 feet. Loess-covered ridges on the Roubidoux Formation give way to valleys cut into Gasconade dolomite. Historically the LTA was mixed-oak woodland; today it is in pasture on uplands and ridges and in dense oak forest on slopes and in valleys. The LTA is similar to the Little Piney Oak Woodland Dissected Plain on the opposite side of the upland at Licking.
OZ5v Little Piney Oak Woodland Dissected Plain	The U-shaped LTA occupies the eastern and western fringes of the Little Piney River valley mostly in Phelps County. Boundaries are drawn to define a landform with local relief of 100–150 feet. Between the two branches the land is very deeply dissected along the Little Piney River.	The LTA consists of a moderately rolling landscape underlain mainly by the Roubidoux Formation on the outer fringes of the Little Piney River basin. Soils are generally deep, cherty silt loams with occasional shallow soils over bedrock. Historically the LTA was dominated by mixed-oak woodland; today it is an even mix of fescue pasture and dense second-growth oak forest. Occasional pine plantations occur. Large portions lie within the Mark Twain National Forest. The LTA is similar to the Big Piney Oak Woodland Dissected Plain on the opposite side of the upland at Licking.
OZ5w Salem Oak Savanna/ Woodland Plain	The LTA is a horseshoe-shaped upland in Dent County surrounding Dry Fork Creek, a tributary to the Meramec River. Boundaries are drawn to encompass the plains landform with less than 100 feet of local relief. The southern boundary is conspicuous in the landscape; it is easily placed where the Salem plain breaks off sharply into the deeply dissected lands of the Current River basin.	The LTA is a high, broad, flat to gently rolling upland surface between the Piney, Meramec, and Current River drainage basins. Local relief is generally less than 100 feet, caused as much by extensive differential solution of the bedrock as by fluvial processes. The upland has numerous sinkholes and solution basins, some of which hold water perennially. The upland serves as a catchment area for groundwater that emerges in large springs in surrounding hill regions. The surface has a thin layer of loess over the Roubidoux Formation. Minor areas of Gasconade dolomite also occur. Soils are mainly droughty with a fragipan. Historically the LTA was a landscape of post oak barrens (possibly with prairie openings) with mixed-oak woodland in more broken topography. Today it is mainly fescue pasture with occasional dense woodlots and forests on steep slopes.

LANDTYPE ASSOCIATIONS IN THE CENTRAL PLATEAU SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ5x Upper Meramec Oak Woodland Dissected Plain	The LTA occupies a dissected plain at the headwaters of the Meramec River east of Salem in Dent County. Boundaries on the south and east are on watershed divides and rather conspicuous in the landscape as breaks in land roughness. The northern boundary is placed where relief increases to more than 200 feet in the Meramec valley. The western boundary is placed where relief decreases to less than 100 feet on the Salem karst plain.	The LTA consists of the dissected area with moderate slopes in the headwaters of the Meramec River. Broad, smooth ridges are interspersed with shallow, broad valleys. The local relief is less than 150 feet but is not flat, and increases to 200 feet in major valleys. The LTA is underlain by the Gasconade Formation and soils that are mainly deep, cherty silt loams. Historically, the LTA was dominated by mixed-oak woodland with scattered shortleaf pine. Today, it is largely timbered in dense second-growth forest; the valley bottoms are cleared pasture. (The LTA could be considered as part of the Meramec Hills Subsection because of its aquatic affinities with that river system and the easy vegetative transition.)
OZ5y Dry Fork Oak Woodland Dissected Plain	The LTA occupies moderately rolling lands surrounding Dry Fork Creek between Salem and Rolla in Dent and Phelps Counties. Boundaries are drawn to encompass a dissected plains landform dominated by local relief of 100–150 feet, separating it from adjacent, steep-sided hills on the east and upland plains on the west.	The LTA consists of a gently to moderately rolling landscape associated with Dry Fork Creek. Local relief is 100–150 feet and is underlain mainly by the Roubidoux Formation, with Gasconade dolomite in deeper valleys. Solutional processes are pervasive in this LTA with many losing streams, as indicated by the name "Dry Fork"; the groundwater surfaces in large springs nearby. Historically the LTA was dominated by oak woodland; today it is a nearly even mix of pasture and dense second-growth oak forest.
OZ5z Rolla Oak Savanna/ Woodland Plain	The LTA occupies a high, flat plain at and south of Rolla. Boundaries are drawn to define the plain as a landform with less than 100 feet of local relief.	The LTA consists of a small, flat to gently rolling plain, underlain by Jefferson City–Cotter dolomite with a thin loess cap. Soils are mainly droughty with a fragipan. Historically it was oak savanna and woodland; today it is largely in urban land use at Rolla and some fescue pasture farther away.
OZ5aa Gasconade-Bourbeuse Oak Savanna/Woodland Plain	The LTA occupies a narrow upland divide in Maries, Gasconade, and Franklin Counties between the Bourbeuse and Gasconade Rivers and between the Bourbeuse and Missouri Rivers. The western boundary is the watershed divide, and it is exceptionally sharp from Rolla almost as far north as US 50. The northern boundary is drawn where loess becomes important in the landscape. The southeastern boundary is drawn where relief increases along the Bourbeuse River.	The LTA consists of the western and northern fringe of the upper Bourbeuse River basin. It is a flat to gently rolling plain with local relief less than 100 feet and is underlain by Pennsylvanian sandstone, which yields highly acidic soils. Clay is mined in pits in the northern parts. Historically it was post oak savanna and mixed-oak woodland with numerous prairie openings; today the landscape is mainly fescue pasture, isolated woodlots, and second-growth oak woods. US 50 traverses the northern end of this unit. The Bourbeuse-Meramec Oak Savanna/Woodland Plain LTA is the counterpart to this LTA on the other side of the Bourbeuse basin.
OZ5bb Bourbeuse-Meramec Oak Savanna/Woodland Plain	The LTA occupies a narrow upland divide between the Bourbeuse and Meramec Rivers from St. James to St. Clair across Phelps, Crawford, and Franklin Counties. The southeastern boundary is the watershed divide between the Bourbeuse and Meramec Rivers and is a very sharp line in the landscape. The northeastern boundary is drawn where relief increases above 100 feet in the Bourbeuse valley.	The LTA consists of the eastern fringe of the upper Bourbeuse River basin. A flat to gently rolling plain with local relief less than 100 feet, it is underlain by Pennsylvanian sandstone, which yields highly acidic soils. Historically it was post oak savanna and mixed-oak woodland with numerous prairie openings; today the landscape is a nearly even mix of fescue pasture and dense second-growth oak forest. I-44 traverses the LTA between St. Clair and Rolla.
OZ5cc Bourbeuse River Oak Woodland Dissected Plain	The LTA occupies the dissected plain on both sides of the middle Bourbeuse River mainly in Franklin and Gasconade Counties. Boundaries are drawn to separate this more dissected portion of the valley from the lower-relief plains on the basin edges and from the higher-relief hills of the lower Bourbeuse.	The LTA consists of gently to moderately sloping dissected plain underlain by Pennsylvanian sandstone and Ordovician Gasconade and Roubidoux Formations. Relief is generally 100–150 feet. Soils are highly acidic. Historically, the LTA was an oak savanna and woodland mosaic; today it is a nearly even mix of fescue pasture and dense second-growth oak forest. There is very little commercial or town development in this LTA.
OZ5dd Bourbeuse River Oak Woodland Hills	The LTA occupies rugged hills along the lower Bourbeuse River in central Franklin County south of Union. Boundaries are drawn to delimit an area dominated by hills with local relief greater than 200 feet.	The LTA consists of moderately rough hills and steep slopes along the lower Bourbeuse River with local relief of 200–300 feet. The valley cuts through the Roubidoux Formation into the Gasconade Formation. Here the stream valley becomes more entrenched and extravagantly sinuous. Historically, the LTA was timbered in mixed-oak woodland and forest; today it is mainly second-growth oak forest with pastures on uplands and gentler slopes and cropland in the bottomlands along the Bourbeuse.

OZ6
OSAGE RIVER HILLS SUBSECTION

(see map pg. 166–167)



GENERAL DESCRIPTION

The Osage River Hills Subsection is composed of the hilly to rugged lands associated with the Osage River within the Ozark Highlands. It includes lands associated with the Sac, Pomme de Terre, and Niangua Rivers, all of them major tributaries of the Osage, and also the Lake of the Ozarks, Truman Lake, and Pomme de Terre Lake. Its proximity to prairie-dominated ecoregions to the west and north and the presence of extensive areas of shallow to moderately deep and droughty soils make the influence of prairie and open woodlands stronger here than in hill subsections in the Ozarks to the east. Lithology varies from Jefferson City–Cotter–dominated areas in the west to areas underlain by Roubidoux, Gasconade, and Eminence-Potosi Formations in the east. Small areas of Mississippian and Pennsylvanian parent materials occur on the western fringe. Historic vegetation ranged from prairie/savanna complexes on the west to well-forested river breaks on the east. Today the region is a focal point for recreational development associated with the lakes. Rural lands are a nearly even mix of pasture and second-growth oak forest.

LOCATION AND BOUNDARIES

The Osage River Hills Subsection lies in the northwestern Ozarks of central Missouri. It lies along the Osage River and its tributaries and comprises major portions of St. Clair, Benton, Morgan, Camden, and Miller Counties, and portions of Cole, Osage, Maries, Laclede, Dallas, Hickory, Polk, Henry, and Cedar Counties. Its northern and southern boundaries are defined where the greater dissection of these river hills declines to less than 150 feet of local relief. This is a sharp line everywhere with the Prairie Ozark Border Subsection on the north, but a transition with Ozark subsections on the south. The northeastern boundary with the Inner Ozark Border is drawn where loess becomes a significant factor in soils closer to the Missouri River. The western boundary with the Osage Plains is drawn where local relief declines to less than 150 feet. This is also, in general, the change from more resistant carbonate rocks of this subsection to weaker shales of the Osage Plains. Stream dissection makes this boundary an extremely irregular line.

CLIMATE

Mean annual precipitation is 42–43 inches. The wettest months are May–September and the six warmer months of the year account for 60 percent of the annual precipitation (at Lakeside). Annual snowfall averages 16–18 inches. Mean January minimum daily temperature is 17° in the north and 20° in the south. Mean July maximum daily temperature is 90–91°. The growing season averages 210 days. Significant microclimatic variations occur locally because of the deep dissection of the land.

Jim Rathert

Outstanding views of the Osage River from the tops of towering dolomite bluffs are available at Painted Rock Conservation Area in Osage County.

TOPOGRAPHY AND GEOLOGY

The subsection lies on the northwestern flank of the broad Ozark uplift, but a smaller subsidiary dome centered in this region causes the regional northwestward dip of the uplift to be flattened in this subsection. The small dome also permits rocks as stratigraphically low as the Cambrian to be exposed along the lower Osage River (although now mostly submerged under the Lake of the Ozarks). Most of the subsection is underlain by thick, mostly cherty dolomites and sandstones of the Gasconade and Roubidoux Formations of the early Ordovician. The dolomites are soluble and produce karst features, some of which are among the most spectacular in the state. Numerous springs, some very large, are present. The western portion of the subsection is lithologically more complex and includes Ordovician cherty and shaley dolomites of the Jefferson City–Cotter Formation; dolomites, shales, and limestones of the Silurian and Devonian; cherty limestones of the Burlington Formation of the Mississippian; and Pennsylvanian sandstone and shale of the Cherokee-Krebs group. Local relief throughout the subsection is moderately high, 200–350 feet, with local areas over 350 feet. The land is thoroughly dissected with steep slopes and narrow ridges near the valleys, giving way to broader ridges and moderate slopes farther back. Rock outcrops are common. Surficial materials consist of a thick solution residuum of clay and rock fragments, much of them chert left behind by the solution of the carbonate rocks.

SOILS

Soils vary within this subsection based on differences in geologic parent materials, landscape position, and native vegetation. The historic savanna vegetation in areas of Benton, Cole, and Miller Counties resulted in soils with moderately thick, dark surface layers, such as Creldon soils on interfluve surfaces and Eldon soils on backslopes. Most of the soils formed in materials weathered from the Mississippian and Ordovician dolomites. In general, soils weathered from the Ordovician dolomites are higher in soluble bases such as calcium and magnesium than are soils weathered from Mississippian limestones. Deep, low-base soils with red, cherty, loamy to clayey subsoils on backslopes include the Clarksville series. Backslopes with deep soils weathered from Ordovician limestone include the Alred series.

HYDROLOGY

The subsection lies entirely within the Osage River basin. It includes the Osage River itself (middle portion) and its major tributaries, the Sac, Pomme de Terre, and Niangua Rivers. The Osage is the third largest river in Missouri in volume, with an average discharge of 10,900 cubic feet per second (at St. Thomas), exceeded only by the Mississippi and Missouri Rivers. Stream gradients are moderately steep to steep on the smaller streams. Natural streams carry great bed loads of gravel and sand, and their channels are replete with gravel and sandbars. Natural streamflow is highest from March to June and declines very rapidly to a low from August to December, except during periods of heavy or protracted rainfall. Moderate to large springs provide much of the streamflow of the tributaries like the Niangua and help to reduce the seasonality of flow. The subsection lacks natural ponds and lakes, but large reservoirs have been constructed: Lake of the Ozarks and Truman Lake on the Osage, Pomme de Terre Lake on the Pomme de Terre, and much smaller Lake Niangua on the Niangua. The Osage River no longer exists as a river in this subsection, except below Bagnell Dam, and its flow there is highly regulated by discharges from the Lake of the Ozarks. Water in the upper end of the Lake of the Ozarks is noticeably affected by outflow from Truman Lake. Water quality is low from pollution in the Lake of the Ozarks, especially in coves where water depth is less and water motion is restricted. Lake water is also affected by extensive boat activity. Streams more distant from the lake have high water quality in general but can be affected by runoff from residential developments and urbanization. Groundwater in general tends to be of high quality, although high in alkalinity. It may be seriously degraded locally where wastewater treatment systems are inadequate.

TERRESTRIAL NATURAL COMMUNITIES

Historic. Before European settlement, tallgrass prairie intergraded from the surrounding plains (Osage, Springfield, and Central Plateau) into complex mosaics of glades, oak savanna, oak woodlands, and oak forest. Fire from the prairie plains, as well as droughty, shallow soils restricted the development of forest. Most of the timbered lands, especially in the western half of the ecoregion, were open and prone to fire. Oak and mixed-hardwood forests were confined to more broken lands, protected slopes, and bottoms.

Current. While much of the prairie and open woodland country has been converted to fescue pasture, a high percentage of the Osage Hills remains in a mosaic of glade, woodland, and forest. However, these communities have been degraded by overgrazing and repeated timber harvest. In addition, glades and open woodlands have succeeded to cedar thickets and brushy forestland in the absence of fire. Many of the forested bottoms are under lakes or have been cleared for agriculture. Substantial efforts to restore glade and woodland complexes is occurring on public lands with outstanding success.

Major Natural Community Types

Midwest Dry-Mesic Chert and Sandstone Prairie

Central Post Oak Dry Barrens

Post Oak–Blackjack Oak/Bluestem Dry Chert and Sandstone Woodland

Post Oak, Black Oak, Scarlet Oak Dry Chert and Sandstone Woodland

White Oak–Black Oak Dry-Mesic Chert and Sandstone Woodland

Mixed Oak–Hickory/Dogwood Dry-Mesic Chert and Sandstone Forest

White Oak/Dogwood Dry-Mesic Chert and Sandstone Forest

Ozark Dolomite Glades

Red Oak–White Oak–Sugar Maple Mesic Dolomite and Bottomland Forest

Rare and Restricted Natural Communities. Some of the most outstanding examples of oak-dominated chert and sandstone savanna and woodland, and dolomite and sandstone glades in Missouri occur in this subsection. More than 50 outstanding occurrences are known. In addition, approximately ten chert prairies still exist. The region contains the westernmost occurrences of Ozark fens, with at least fifteen known quality occurrences. While not as numerous as in other Ozark subsections, several outstanding caves and springs occur.

NATURAL DISTURBANCES

Because of the proximity to prairie ecoregions, fire would have been pervasive throughout this subsection. Droughty soils would have added to the potential for fire and would have favored grassland species. Grazing by native herbivores would have contributed to the open nature of this landscape.

RARE OR ENDANGERED SPECIES

There are 142 records of 72 state-listed species in the ecoregion. Many of the occurrences are associated with rivers and streams or caves. These include several species whose only occurrence in the state is from the Osage River Hills: a perlid stonefly *(Neoperla carlsoni),* a hornwort *(Notothylas orbicularis),* an elderberry *(Sambucus canadensis* var. *laciniata),* and a moss *(Acaulon muticum* var. *rufescens).* Federally listed species known from the region include gray bat *(Myotis grisescens),* Indiana bat *(Myotis sodalis),* pink mucket *(Lampsilis abrupta),* Niangua darter *(Etheostoma nianguae),* geocarpon *(Geocarpon minimum),* and bald eagle *(Heliaeetus leucocephalus).*

NATURAL AREAS

The Osage River Hills have nine Natural Areas. An excellent example of typical oak woodland/dolomite glade complex occurs at Ha Ha Tonka (and also at Bennett Spring Savanna Natural Preserve of The Nature Conservancy). Dave Rock and Lichen Glade contain outstanding sandstone glade/woodland complexes. Three fens are represented at Big Buffalo Creek Fen, Bennett Spring Hanging Fen, and Coakley Hollow Fen. Bat Cave contains an outstanding effluent cave. Relatively small examples of an Ozark creek and a mixed bottomland hardwood forest occur at Brush Creek and Big Buffalo Creek Forest respectively.

PUBLIC LANDS

The Osage River Hills Subsection has more than 180,000 acres of public land. Most of the acreage is owned by the U.S. Army Corps of Engineers around Truman Lake; some of these lands are leased and managed by the Missouri Department of Conservation. Both the Departments of Conservation and Natural Resources own more than 25,000 acres in the ecoregion. State parks include Ha Ha Tonka, Bennett Springs, Lake of the Ozarks, Pomme de Terre, and Truman. Outstanding Conservation Areas include Big Buffalo Creek, Bluff Springs, Fiery Fork, Lead Mine, Mule Shoe, Painted Rock, and Saline Valley.

Missouri Department of Conservation

The Osage River Hills Subsection is home to the Lake of the Ozarks and Harry S. Truman Reservoir—and their popular recreational opportunities.

HUMAN GEOGRAPHY

Demographics. Osage and other Indian activity was extensive in this subsection, for settlements, hunting, and also for transit on the Osage River. American agricultural settlement began in the 1830s by moving up the Osage River. The early settlers of the region were chiefly Americans of Scotch-Irish ancestry from Tennessee and Appalachia. Population declined in the first half of the twentieth century but has grown at a very fast rate since midcentury, fueled by immigration by a varied mix of people. Areas farther from the lakes have not grown as fast.

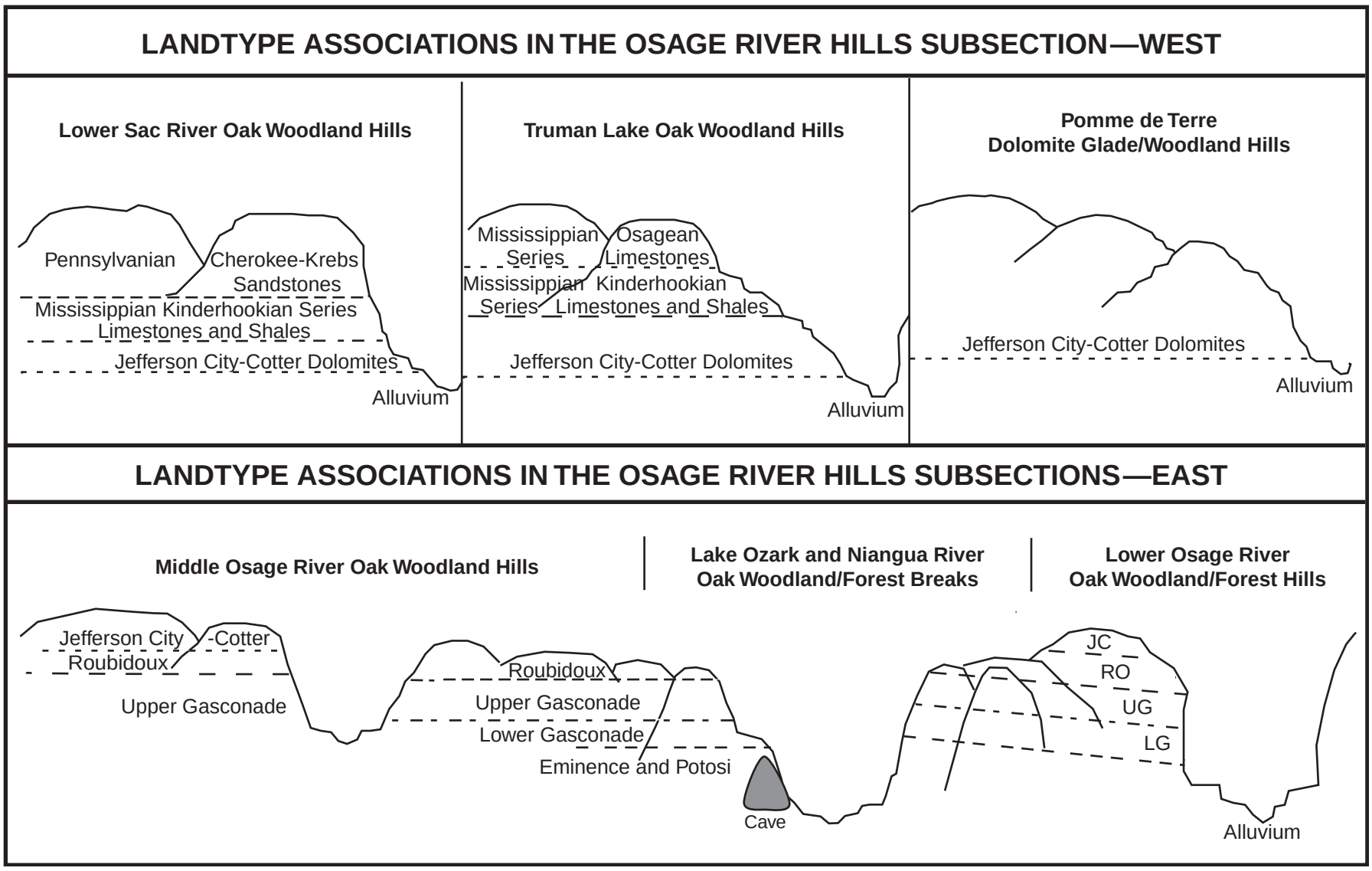
Economics and Land Use. Early land use consisted of patch agriculture and extensive open-range hog and cattle raising in the woodlands and timber. This continued well into the twentieth century. Iron was mined locally. The Osage was a navigable river for steamboats, at least as far as Warsaw, and invited development of industry and shipping points along it. Lacking pine, the subsection's forests were late in being exploited, and railroad crossties were the chief product. Railroads bypassed the hilly subsection and further economic development was delayed. Construction of Bagnell Dam and Lake of the Ozarks in 1931 completely changed the geography of the subsection and introduced new land uses and economics. Forests and woodlands still occupy most of the area, but in many places they are intermixed with residential, recreational, and commercial developments. This is true especially along major highways and around the first-developed, eastern reaches of the Lake of the Ozarks. Truman Lake and the western reaches of the Lake of the Ozarks are much less developed for recreation and tourism. Row crops are rare, except in very small fields in valley bottoms. Pastures occupy some better soils, but they are not widespread. Economic development was slow until after World War II, when explosive growth took place. The economy of the whole subsection now centers on recreation, tourism, and retirement communities around the lake. Construction of Truman Dam and Lake in 1979 added to this economy in the western portion of the subsection.

LANDTYPE ASSOCIATIONS

The Osage River Hills Subsection is subdivided into seven landtype associations (LTAs). They are all hilly or rugged landscapes that vary in the degree of relief and in soil and vegetation patterns. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Osage River Hills Subsection is a principal ecoregion for the maintenance and restoration of oak savanna and woodland ecosystems. Its location adjacent to prairie landscapes and the droughty nature of its soils influence the importance of grassland elements in this ecoregion. Fires and grazing would have moved from the prairies into the Osage River Hills, creating an intricate and diverse mosaic of grassland, savanna, woodland, and forest. In the absence of fire, this diversity has been replaced by dense second-growth timber with few of the original species thriving. Maintenance and restoration of these ecosystems is already proving fruitful on some lands and needs to be continually expanded. In addition numerous springs, caves, and fen communities support a wide variety of unique species and need attention. Streams of the region are home to numerous rare elements. Development and urbanization associated with the large lakes and towns of the region will continue to grow and affect these species and ecosystems.



(see landtype associations map pg. 166–167)

LANDTYPE ASSOCIATIONS IN THE OSAGE RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ6a Lower Sac River Oak Woodland Hills	The LTA is located along the lower Sac River in Cedar and St. Clair Counties between Stockton and Osceola. Boundaries are drawn to encompass hills with over 100 feet of local relief that are associated with Pennsylvanian sandstone. The LTA is related by geology to the Osage Plains, but topography, soils, vegetation, and hydrologic patterns tie it more conclusively to the Osage River Hills.	The LTA consists of moderately rolling to rugged hills with steep slopes underlain by Pennsylvanian sandstones. Broad ridges at the edge of the LTA give way abruptly to deeper valleys. Local relief is 100–250 feet or more next to the major rivers. Historically, the LTA had sandstone glades, savannas, and woodlands interspersed with small prairie openings. Today, fescue pasture has replaced most of the open lands, but substantial second-growth woodland with good restoration potential remains. Several high-quality sandstone glade/savanna sites are protected on public land, some with federally listed *Geocarpon* and many with unique moss species. Several bald eagle nests are also prominent.
OZ6b Truman Lake Oak Woodland Hills	The LTA occupies the hills surrounding Truman Lake between Warsaw and Osceola, excluding the Pomme de Terre River basin. The LTA is separated from plains to the north and south by a rather abrupt change to landscapes with relief of less than 100 feet. The boundary with the Sac River Hills marks a change to Pennsylvanian sandstones, and the boundary with the Middle Osage River Hills marks a change to Roubidoux and Gasconade Formations. The boundary with the Pomme de Terre Hills is a line identifying a separate drainage basin.	The LTA consists of moderately dissected, steep-sided hills surrounding Truman Lake. Upland ridges of Mississippian limestones and shales give way to moderately steep valleys cut into the Jefferson City–Cotter dolomites. Local relief near valleys is 200–250 feet. Historically, the LTA was in oak savanna and woodland; today the landscape is mainly timbered in dense second-growth mixed-oak forest. Pasturelands are common on ridges, and overgrown glades are common on thin soils near the lake. Several active bald eagle nests and heron rookeries are present. Substantial acreages of public lands are located around the lake. Recreation development is active around Warsaw.

LANDTYPE ASSOCIATIONS IN THE OSAGE RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ6c Pomme de Terre Dolomite Glade/Woodland Hills	The LTA occupies the hilly lands of the Pomme de Terre River basin between Pomme de Terre and Truman Lakes in Hickory and southern Benton Counties. Boundaries with plains on the east and west are placed along a rather abrupt break from hills to uplands with less than 100 feet of local relief. The southern boundary marks a transition to dissected plains with less than 150 feet of local relief. The northern boundary is a simple watershed boundary.	The LTA consists of moderately dissected, steep-sided hills associated with the lower Pomme de Terre River. The region is underlain principally by Jefferson City–Cotter dolomites. It contains Pomme de Terre Lake and a major arm of Truman Lake. Historically, the LTA contained dolomite glade/woodland complexes, but mixed-oak dry chert woodland was dominant. Today, the region is largely timbered in dense second-growth forest and overgrown glades. Pastures dominate the higher flats. Several bald eagle nests and endangered bat caves are present. In addition, the LTA has the only state location for a rare elderberry, *Sambucus canadensis* var. *laciniata*. The LTA contains several large tracts of public land associated with the two large lakes.
OZ6d Middle Osage River Oak Woodland Hills	The large LTA occupies the hills of the middle Osage River and lies on both sides of Lake of the Ozarks. It includes an eastern extension along the northern border of the subsection and a noncontiguous tract along the Auglaize Creek south of Lake of the Ozarks State Park. The LTA includes Cole Camp, Big Buffalo, and Deer Creeks, as well as the upper reaches of the Little Niangua River. It lies mostly in Morgan and Benton Counties but includes parts of Camden, Hickory, and Miller Counties. The northern boundary is the exceptionally abrupt and conspicuous topographic break with low-relief plains. The southern boundary is more transitional to a dissected surface with less than 100 feet of relief. The western boundary marks where Jefferson City–Cotter dolomites begin. The long boundary on the east marks the transition to steeper lands of higher relief and narrower ridges.	The LTA consists of moderately dissected hills with narrow ridges with steep sides. Uplands with less steep slopes are on Jefferson City–Cotter dolomites, and the steeper hills with deeper valleys are cut into Roubidoux and Gasconade Formations. Soils range from deep, cherty silt loams to shallow soils over dolomite bedrock. Historically, the higher, smoother uplands were dominated by oak savanna and woodland with scattered prairie openings, while more rugged lands were likely oak woodland with scattered glades. Today, the region is dominated by pasture, with dense second-growth oak forest in rougher topography. Several unique fen communities occur. Endangered bat caves and bald eagle nests are also present. The upper Little Niangua River has federally listed Niangua darters and is considered an outstanding stream. Locally, recreational development pressures may be intense, especially around Eldon and at lakeshore sites.
OZ6e Niangua River Oak Woodland/ Forest Breaks	The LTA occupies the rugged river breaks associated with the Niangua River from its junction with the Little Niangua upstream to just beyond Bennett Spring State Park. Boundaries are drawn to encompass the breaks topography, including narrow ridges, steep sideslopes, and narrow, sinuous valleys; this type of landscape is sharply set off from neighboring plains. The northern boundary is a simple watershed line.	The LTA consists of very rugged lands with local relief of 250–350 feet or more. Ridges are narrow crested, sideslopes are steep with frequent rock outcrops, and valley bottoms are narrow and sinuous. The highest ridges are on the Roubidoux Formation, and valleys are cut into the Gasconade Formation and even into the Eminence-Potosi Formation. The LTA contains numerous well-developed karst landscapes, including some of the best in the state. Shallow to moderately deep, cherty soils over dolomite bedrock are common. Historically, extensive dolomite glade/savanna complexes dominated the landscape, embedded in a matrix of oak woodland and forest; this continues today except that savannas and woodlands are fewer and second-growth forest more abundant. Mixed-hardwood forests are confined to protected slopes and alluvial plains. Cliffs, caves, springs, and outstanding streams are common. Numerous outstanding glade/savanna complexes, karst features, and rare bat caves are present, many of them on public lands, including Bennett Springs and Ha Ha Tonka State Parks and Lead Mine Conservation Area. Recreational development pressures are intense around Camdenton and the Niangua arm of the Lake of the Ozarks.

(table continued on pg. 114)

Jim Rathert

Lichen Glade Natural Area contains outstanding sandstone glades and woodlands common in the western portion of the Osage River Hills.

LANDTYPE ASSOCIATIONS IN THE OSAGE RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ6f Lake of the Ozarks Oak Woodland/Forest Breaks	The LTA occupies the rugged lands surrounding the main body of the Lake of the Ozarks and the Osage River from Bagnell Dam to near St. Elizabeth. Boundaries are drawn to enclose breaks topography with narrow ridges, steep sideslopes, and narrow, sinuous valleys and with local relief of at least 250 feet. The southern boundary with the Niangua River Breaks (a similar landtype) is a watershed boundary.	This large LTA consists of rugged hills with local relief from 250 feet to more than 350 feet. Narrow ridges, steep sideslopes with rock outcrops, and sinuous, narrow valleys prevail everywhere. The highest ridges are on the Roubidoux Formation, while valleys are cut into the Gasconade and Eminence-Potosi Formations. Soils are cherty, moderately deep loams over dolomite with shallow, cherty soils on steeper slopes. Historically, the LTA had extensive dolomite glade/savanna complexes embedded in a matrix of oak woodland and forest, which still continues except that the glade/savanna complexes are degraded and overgrown in the absence of fires, the woodlands are much less extensive, and second-growth hardwood forests have increased. Mixed-hardwood forests are confined to protected slopes and alluvial plains. Little land is in cleared pasture except in the Osage River bottoms, since most of the largest bottoms are submerged under the Lake of the Ozarks. A substantial number of rare bat caves and bald eagles nests and roosts are present. In addition, several rare mussel species are known from streams in the region. This landscape is very heavily affected by urbanization and recreational development associated with the Lake of the Ozarks, especially along highways and on lakesides.
OZ6g Lower Osage River Oak Woodland/Forest Hills	The LTA occupies rugged hills flanking the lower Osage River from near St. Elizabeth to the mouth of the Maries River. The southeastern boundary marks the change of relief to less than 150 feet. The western boundary marks a change of relief to greater than 250 feet farther up the Osage River. The northwestern boundary is the drainage divide between the Osage and Moreau Rivers and also marks, in general, a change to a landscape heavily influenced by loess.	The LTA consists of deeply dissected hills with a local relief averaging 200–250 feet. Narrow ridges give way to steep-sided hills that have bold bluffs along the Osage River. The landscape on the Jefferson City–Cotter and Roubidoux Formations is somewhat less steep but still rocky, while the valleys cut deeply into the Gasconade Formation have steeper valley sides. Historically, oak woodland was dominant and graded into mixed-oak and mixed-hardwood forest in rougher lands. Today, the LTA is a mosaic of primarily pasture with small, isolated woodlots, cedar thickets, and tracts of second-growth forests. Several rare mussel species are associated with the Osage River. Painted Rock Conservation Area is one of the few public lands in the LTA. The discharge of the Osage River is regulated by outflow from the Lake of the Ozarks. Development pressures occur close to Jefferson City.

Fire maintained open oak woodlands once dominated the Osage River Hills. Fire is being used to restore this woodland at Bennett Springs Preserve in Laclede County.

Tim Nigh

OZ7
GASCONADE RIVER HILLS SUBSECTION

(see map pg. 168–169)

GENERAL DESCRIPTION

The subsection consists of the deeply dissected portion of the Gasconade River basin. Steep slopes, narrow ridges, and narrow valley bottoms occur virtually everywhere. Soils are rocky and frequently thin over carbonate and sandstone bedrock principally of the Roubidoux and Gasconade Formations. Local karst and large springs are characteristic. Mixed-oak and oak-pine woodland and forest dominated the presettlement vegetation. Second-growth oak forests now cover most of the region. Human influences are substantial along the I-44 corridor and in the vicinity of Fort Leonard Wood and Rolla.

LOCATION AND BOUNDARIES

The Gasconade Hills Subsection lies in the central and northern Ozarks completely on the northern side of the Ozark regional drainage divide. It includes portions of Gasconade, Osage, Maries, Phelps, Dent, Pulaski, Laclede, Webster, Wright, and Texas Counties. The subsection is characterized by deep dissection and moderate to high local relief along the Gasconade River, and its boundaries are defined by a reduction of local relief to less than 150 feet. This line is very sharp across Maries and northern Pulaski Counties but is transitional elsewhere. The short northern boundary with the Inner Ozark Border is placed where loess over the Jefferson City–Cotter Formation becomes a significant factor closer to the Missouri River. Small areas of dissected plain with less than 150 feet of local relief on Roubidoux sandstone are included to link former pine-oak woodland landscapes to the subsection.

CLIMATE

Mean annual precipitation is 40–43 inches. The wettest months are May–July and 57 percent of the annual precipitation occurs during the six warmer months of the year (at Rolla). Annual snowfall averages 14–18 inches. Mean January minimum daily temperature is 18° in the north and 20° in the south. Mean July maximum daily temperature is 91° but is only 89° in the south because of higher elevations. The growing season averages 210 days. Significant microclimatic variations occur locally because of the deep dissection of the land.

TOPOGRAPHY AND GEOLOGY

The subsection lies on the northern flank of the broad Ozark uplift. Strata dip gently northwestward, although locally they appear to be horizontally bedded. Most of the subsection is underlain by thick, mostly cherty dolomites and sandstones of the Gasconade and Roubidoux Formations of the early Ordovician. The dolomites are highly soluble and produce prominent karst features, including large springs, losing streams, and sinkholes, some of which are among the deepest in the state. The higher slopes and drainage divides are underlain by dolomites of the Jefferson City–Cotter Formation of the later Ordovician. Local relief throughout the subsection is moderately high, 200–400 feet. Except along its edges, the surface is thoroughly dissected into narrow ridges and narrow valleys with steep slopes. Rock outcrops of dolomite and sandstone are common and include bold and high cliffs along the Gasconade and Piney Rivers. Surficial materials consist of a thick residuum of clay and rock fragments, mostly chert left behind by the solution of the carbonate rock.

SOILS

Soil patterns are closely related to bedrock lithology and landscape position in this subsection. Soils formed in residuum from the Roubidoux Formation are low in soluble bases such as calcium and magnesium. These include the very deep, well-drained Doniphan soils on convex summits and shoulders, with red clay subsoils; and the very deep, well-drained Clarksville soils on backslopes, with very cherty red subsoils. On lower backslopes, the Gepp soils are higher in bases. These soils are very deep and well drained, with red clay subsoils. Other backslope soils include the moderately deep Gatewood soils over dolomite, and the shallow Gasconade soils in glades. Viraton soils are on broad interfluve summits and have a root-restricting fragipan in the subsoil.

HYDROLOGY

The subsection lies entirely within the Gasconade River drainage basin. It includes the Gasconade River itself and its major tributaries, the Little Piney, Big Piney, Roubidoux, and Osage Fork. Stream gradients are moderately steep to steep on the smaller streams. The Gasconade near Waynesville drops about 2.6 feet per mile. Streams carry great bed loads of gravel and sand; their channels are full of gravel and sandbars and consist of alternating pools and riffles. There is little suspended sediment in motion. Natural streamflow is highest in spring and declines rapidly through the summer to a low in late autumn, except during periods of heavy or sustained rainfall. Flooding occurs naturally, since there are no flood-control structures in the basin. Springs are numerous, including some very large ones, and they provide significant amounts of base flow to the steams and mitigate against high seasonal fluctuations. The subsection lacks natural ponds and lakes, but small lakes and ponds have been constructed for water supplies and stock watering. Water quality is generally good, although it is subject to local pollution from built-up

Jim Rathert

The lower Gasconade River has broad bottoms that are often farmed.

areas. Springwater and groundwater in general tend to be of high quality, although high in alkalinity. Groundwater tends to move relatively fast because of the widespread solution of bedrock and ease of water movement through openings in the rock mass.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The highly dissected landscape along the Gasconade River and its tributaries (notably the Big Piney) was repeatedly described by early land surveyors as "hilly, stony, thin soil, unfit for cultivation." A mosaic of oak savanna, woodland, and forest communities on cherty and sandstone substrates occupied the uplands. Shortleaf pine-oak woodlands and forests were present along the Big Piney and Little Piney Rivers and as small disjunct stands on outcrops of Roubidoux sandstone as far north as the mouth of the Big Piney. Glades were scattered throughout. Alluvial plains were wooded, either oak woodland or riverfront and mixed-hardwood bottomland forest. A few toe slopes and second bottoms, especially on the western banks of the rivers, may have been small prairies.

Current. Except where cleared for livestock, pastures and a few shortleaf pine plantations, the upland communities of oak and oak-pine woodland and forest remain. However, their structure and composition has been altered by management; second-growth forests tend to be denser and have a diminished pine component. The bottomlands have mostly been cleared and put in fescue pasture with small acreages of corn. Well-developed bottomland forest occurs in fragments.

Major Natural Community Types

Post Oak, Black Oak, Scarlet Oak Dry Chert and Sandstone Woodland

Shortleaf Pine–Oak/Bluestem Dry Chert and Sandstone Woodland

Shortleaf Pine–Oak/Vaccinium Dry Chert and Sandstone Woodland

White Oak–Black Oak Dry-Mesic Chert and Sandstone Woodland

Mixed Oak–Hickory/Dogwood Dry-Mesic Chert and Sandstone Forest

White Oak/Dogwood Dry-Mesic Chert and Sandstone Forest

Red Oak–White Oak–Sugar Maple Mesic Dolomite and Bottomland Forest

Rare or Restricted Natural Communities. Roubidoux sandstone glades are rare and confined to this subsection; dolomite glades are infrequent. While not as common as to the southeast, several high-quality fens, sinkhole ponds, and effluent caves occur. Undisturbed forest and woodland communities are rare; fewer than ten old-growth sites are known. Few true oak-pine woodlands remain. Springs and caves are numerous, but pristine examples are uncommon; all are sensitive to human disturbance.

NATURAL DISTURBANCES

Frequent fires kept the understory open in woodlands and maintained glades. Drought, storms, and grazing by native herbivores would also have altered the structure of woodlands. Flooding affected bottomland vegetation.

RARE OR ENDANGERED SPECIES

The Heritage Database lists over 400 occurrences of 76 state-listed species in the Gasconade River Hills Subsection. Several species have their only occurrences in Missouri in this subsection. They include a perlid stonefly *(Acroneuria ozarkensis),* Torrey's bulrush *(Schoenoplectus torreyi),* and a moss *(Zygodon apiculatus).* Species of federal concern include gray and Indiana bats *(Myotis grisescens* and *M. sodalis),* pink mucket *(Lampsilis abrupta),* and bald eagle *(Heliaeetus leucocephalus).* Habitats supporting an exceptionally high number of listed species include caves, rivers and streams, bottomland forest, and upland woodland and forest. Many of the records are consequently clustered close to rivers.

NATURAL AREAS

The subsection has four designated Natural Areas that represent a limited number of the features. An old-growth shortleaf pine–oak woodland is the principal feature at Eck Memorial. Spring Creek Gap Glades contains an exceptional dolomite glade/woodland complex. Unusual geologic features occur at Clifty Creek and Horseshoe Bend.

PUBLIC LANDS

The subsection has more than 180,000 acres of public land. Most of the acreage is in the Rolla-Houston District of Mark Twain National Forest. The Missouri Department of Conservation owns 7,200 acres, much of which is in river accesses. Spring Creek Gap, Canaan, and Eck Conservation Areas are prominent. No state parks are located in the subsection.

HUMAN GEOGRAPHY

Demographics. Osage and other Indian activity was extensive in this subsection for settlements, hunting, and as a region of transit on the Gasconade River and numerous trails. The first Americans (1810–1830) were hunters and trappers and those cutting pine timber for the St. Louis market. Permanent, agricultural settlement began in the 1820s, and by the Civil War the best farmable bottomlands were occupied. The early settlers of the Gasconade basin were chiefly westering Americans of Scotch-Irish ancestry from Tennessee and Appalachia. Since the mid-twentieth century a varied mix of people have moved into the I-44 corridor, Rolla, and Fort Leonard Wood vicinity. Rural population reached a peak early in the twentieth century, then declined, but resumed growth at a strong rate in the last quarter of the century.

Economics and Land Use. Nineteenth-century farming consisted of small patches of corn and other crops and extensive, open-range cattle and hog raising in timbered lands. Land clearing and farming on the ridges did not begin until later in the century. In the twentieth century crop farming declined and is now restricted to fields in the larger bottomlands. Farming has concentrated on cattle raising in fenced pastures. Since World War II the economy in the central part of the Gasconade basin has been tied to the establishment and growth of Fort Leonard Wood. Other commercial and service activities have developed along I-44. Non-farm activities, including recreation and tourism, now completely overshadow the farm economy, despite the spread of grazing. Fort Leonard Wood, Waynesville, and Rolla are the growth poles of the subsection.

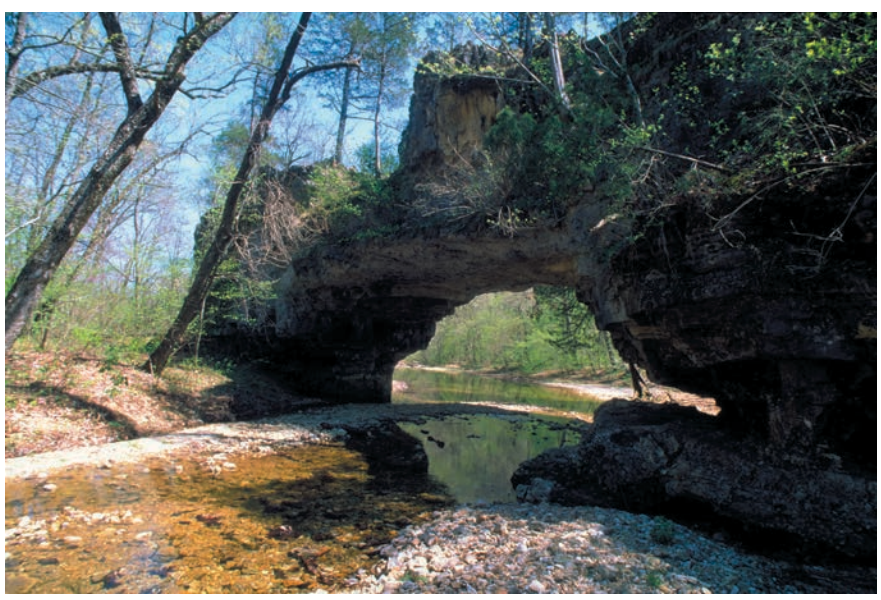
LANDTYPE ASSOCIATIONS

The Gasconade River Hills Subsection is subdivided into eleven landtype associations (LTAs). Gently rolling oak woodland hills and dissected plains occur at the edge of the valley and give way to more rugged oak and oak-pine woodland/forest hills and breaks. The edge of the Piney River valley has narrow pine-oak woodland plains that were historically nearly pure shortleaf pine woodland. The LTAs are illustrated on the maps and described on the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

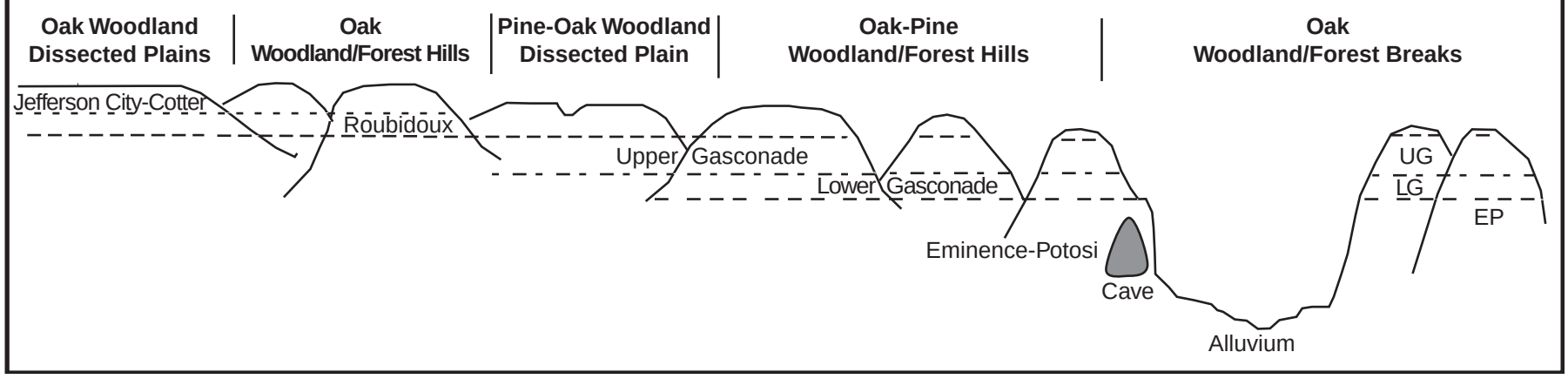
The Gasconade River Hills have a wide variety of landscapes and natural communities. Public lands do not represent the wide variety of landscapes of the subsection, and thus significant opportunity to maintain and enhance native ecosystems remains. Conservation goals should include the maintenance and restoration of native oak and pine-oak woodland communities and the protection of sensitive cave and aquatic resources. Development associated with the I-44 corridor and around Fort Leonard Wood and Rolla will continue to affect conservation opportunities.

Clifty Creek Natural Area in Maries county has a scenic natural bridge.



Jim Rathert

LANDTYPE ASSOCIATIONS IN THE GASCONADE RIVER HILLS SUBSECTION



(see landtype associations map pg. 168–169)

LANDTYPE ASSOCIATIONS IN THE GASCONADE RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ7a Upper Gasconade Oak Woodland Hills	The LTA occupies the hills associated with the upper Osage Fork and Gasconade Rivers above Richland. Boundaries are drawn to encompass hills with over 150 feet of local relief. The downstream boundary with the Middle Gasconade River Oak Woodland/Forest Breaks LTA marks a change into an area of much higher relief.	The LTA consists of broad ridges and moderately dissected hills associated with the Jefferson City–Cotter and Roubidoux Formations, which give way to steep slopes at lower elevations that are cut into the Gasconade Formation. Local relief is generally 200–250 feet or more and includes vertical cliffs along the rivers. Solutional processes have helped shape the landscape and hydrology. Soils are mainly deep, cherty silt loams with many places with shallow soils over bedrock. Historic vegetation was mainly mixed-oak woodland that increased in density closer to river valleys. Today the region is dominated by pasture, with small, isolated patches of dense second-growth forest. Numerous rare bat caves and fish associated with the streams are present.
OZ7b Upper Gasconade Hills Oak Woodland Dissected Plain	The LTA occupies two geographically separate, narrow divides between the upper Gasconade River and the Osage Fork on the west and the upper Gasconade River and Roubidoux Creek on the east. Boundaries are drawn to separate these two lower-relief plains from adjacent hills.	The LTA consists of two narrow, slightly dissected upland surfaces. The surfaces average 50–150 feet of local relief, much of it karstic, and are underlain mainly by Jefferson City–Cotter dolomite. Historically, oak savanna and woodland dominated. Today, about half is cleared pasture and half is dense second-growth oak forest or pine plantations. Most of the land is in Mark Twain National Forest. Several sinkhole ponds, one with the only known location for Torrey's bulrush *(Scirpus torreyi),* are in this LTA.
OZ7c Roubidoux Creek Oak Woodland/Forest Hills	The LTA occupies the hilly upper reaches of Roubidoux Creek, mostly above Fort Leonard Wood. Boundaries are drawn to encompass the hills landscape with over 150 feet of local relief. The southern boundary marks the upper limit of the Roubidoux Formation in the valley.	The LTA consists of moderately dissected hills. Broad ridges with moderate slopes associated with the Jefferson City–Cotter and Roubidoux Formations give way to steep slopes cut into the Gasconade Formation. Local relief is 200–250 feet or more with occasional cliffs along the river, especially in its lower reaches. The Roubidoux is a losing stream through much of this LTA and karst features are otherwise prominent. Historically, the LTA was in oak woodland high in the landscape, grading into mixed-oak forest on lower slopes. Today, the upper reaches are dominated by cleared pasture in the broader bottoms, with large blocks of second-growth oak forest in the uplands. The lower reaches are mainly timbered in oak and oak-pine forest. Rare bat caves and fish species are significant heritage features.
OZ7d Big Piney Hills Oak Woodland Dissected Plain	The LTA is located on the smooth divide between the Roubidoux Creek and Big Piney River. Boundaries are drawn at 150 feet of relief to separate this lower-relief plain from adjacent hills.	The LTA consists of a slightly dissected upland plain with less than 150 feet of local relief. It is underlain mainly by Jefferson City–Cotter dolomite, but the Roubidoux Formation occurs along its margins. Solutional processes affect the landscape. Fragipan soils in loess over dolomite occur on the highest surfaces and deep cherty silt loams on areas of more relief. Historically, the LTA was a mosaic of oak woodland and occasional patches of pine-oak woodland. Today, the landscape is mainly pasture on the flattest lands and dense second-growth oak forest or pine plantations on steeper slopes. Most of the LTA is in the Mark Twain National Forest and Fort Leonard Wood. A couple of rare bat caves are present.

(table continued on pg. 118)

LANDTYPE ASSOCIATIONS IN THE GASCONADE RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ7e Big Piney River Oak-Pine Woodland/Forest Hills	The LTA is located in the hilly to rugged lands along the upper Big Piney River, mostly above Fort Leonard Wood. Boundaries are drawn to encompass a landscape with over 150 feet of local relief. The northern boundary marks a change to a more rugged breaks landscape and one outside of the natural range of pine.	The LTA is similar to the Roubidoux Creek Oak Woodland/Forest Hills, except for the major presence of pine along the Big Piney. The LTA is a well-dissected belt of hills with local relief above 150 feet. Topography ranges from broad ridges with moderately steep sideslopes in the upper reaches to steep rugged lands of more than 250 feet of local relief in the lower (northern) reaches. The lower reaches are breaks-like in their slope form, but their small size retained them in this LTA. Cliffs, caves, and springs are common in this heavily karstic region. Historic vegetation was primarily pine-oak and mixed-oak woodland and forest. Today most of the bottoms are in cleared pasture, while the uplands are densely timbered in second-growth forest. A major pine component has persisted, as evidenced by the name of Big Piney. Eck Memorial Natural Area has outstanding old-growth pine-oak woodland. Rare bat caves and fish species are prominent heritage features. Much of the LTA is in USDA Forest Service ownership.
OZ7f Fort Leonard Wood Oak Savanna/Woodland Plain	The LTA occupies an isolated upland plain between Roubidoux Creek and the Big Piney River that forms the center of Fort Leonard Wood. Boundaries are drawn to encompass the plain with less than 75 feet of local relief.	The LTA is a very small but very distinctive, slightly dissected plain with relief of less than 75 feet. It is underlain by Jefferson City–Cotter dolomite and is affected by solutional processes. Historically it was post oak savanna and woodland with isolated prairie openings. Today it is completely within Fort Wood, which develops and manages the entire LTA.
OZ7g Middle Gasconade River Oak Woodland/Forest Breaks	The LTA occupies the steep, rugged lands of the middle Gasconade River from MO 7 near Richland in Pulaski County to just above US 63 in Maries County. It includes the lower Roubidoux Creek and the lower Big and Little Piney Rivers north of the range of pine. Boundaries are drawn to encompass steep, intricately dissected lands with over 250 feet of local relief. Boundaries are usually quite noticeable in the landscape since they mark a change from rounded hills to those that "break," or steeply drop from the uplands, often with rock ledges.	The LTA consists of deeply dissected hills with narrow ridges, steep sideslopes, and deeply entrenched and sinuous stream valleys. Local relief is everywhere above 250 feet and ranges above 350 feet along the deepest valleys. Major valley bottoms are broad for the Ozarks. Higher elevations are underlain by the Roubidoux Formation and lower elevations by the Gasconade Formation. Karst influences are significant throughout, including major caves and large springs. Cliffs, caves, and springs are mostly in the Gasconade Formation. Soils are mainly deep, cherty silt loams with low-base ultisols associated with the Roubidoux Formation and higher-base alfisols in the Gasconade residuum. Historically, the LTA was timbered in mixed-oak woodland and forest with frequent mixed upland and bottomland hardwood forest. Glade/woodland complexes also occurred. Today, most of the uplands are in dense second-growth oak forest, while most of the bottomlands are cleared pasture. Glades are largely overgrown with cedar. Numerous rare bat caves and fish are prominent heritage features. Extensive commercial and residential development occurs along the I-44 corridor, especially at Waynesville, St. Robert, and Newburg.
OZ7h Middle Gasconade River Oak Woodland Benchland	The LTA is located on the northwestern lip of the middle Gasconade River valley from Richland downstream across Pulaski County to US 63 in Maries County. The northern boundary is the drainage divide with the Osage River basin; it is a very sharp line in the landscape that marks the abrupt change from low-relief plains to the rugged hills of the Gasconade valley. The southern boundary marks the break to a steeper, higher-relief river breaks landscape of the "inner" Gasconade valley.	The LTA consists of a narrow strip of elevated benchland that lies at an intermediate, "suspended" elevation between the higher rim of the valley and the lower bottomlands. It is moderately dissected to a local relief of 150 feet, but all ridgetops lie at the same elevation. The benchland is upheld by the Roubidoux sandstone. Historically, it had a cover of oak savanna and woodland with frequent prairie openings. Today, it is mainly pasture and isolated woodlots on the smoother ridges of the bench with second-growth forest in the ravines and valleys. MO 133 and MO 28 run along the outer crest of the benchland.
OZ7i Little Piney River Oak-Pine Woodland/Forest Hills	The LTA occupies the hilly lands in the upper Little Piney River basin within the natural range of pine. Boundaries are drawn to encompass hills between 150 and 250 feet of local relief. The northern boundary separates this LTA from more rugged breaks that lie outside the natural range of pine.	The small LTA consists of ridges on Roubidoux Formation that give way to moderately steep hills cut into the Gasconade Formation. Valleys are somewhat broad, probably due to long-term solutional processes. Local relief is 150–250 feet. Historically, the LTA was in oak and pine-oak woodland and forest. Today, most of the bottoms are cleared pasture, and uplands are dense second-growth mixed-oak forest with tracts of natural or planted pine. Most of the LTA is in the Mark Twain National Forest. Several outstanding fen complexes and sandstone glade and woodland communities are on USDA Forest Service lands.

LANDTYPE ASSOCIATIONS IN THE GASCONADE RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ7j Big Piney Pine-Oak Woodland Dissected Plain	The LTA occupies several narrow belts along the outer edge of the upper Big Piney River valley as far as Houston in Texas County. Boundaries are drawn to include dissected plains with less than 150 feet of local relief that have natural pine woodlands.	The LTA consists of small, slightly dissected plains of less than 150 feet of local relief on Roubidoux sandstone along the edge of the upper Big Piney River basin. The distinguishing feature is the presence of native pine and pine-oak woodlands that predominated historically as well as today. About half of the LTA is in the Mark Twain National Forest.
OZ7k Lower Gasconade River Oak Woodland/Forest Hills	The LTA occupies the hills flanking the lower Gasconade River from US 63 to US 50 and lies mostly in Maries and Osage Counties. Eastern and western boundaries are drawn to mark the transition to plains with local relief less than 150 feet. They lie mostly on drainage divides with the Maries on the west and the Bourbeuse on the east. The northern boundary marks the transition to the loess-covered, Jefferson City–Cotter Inner Ozark Border. The southern boundary marks the transition to much more rugged breaks.	The relatively large LTA consists of moderately dissected hills flanking the lower Gasconade River. Broad, undulating ridges give way to steep-sided hills near the river with occasional rock-faced bluffs. Local relief is generally 200–250 feet. The more gently rolling uplands are underlain by Jefferson City–Cotter and Roubidoux Formations, while the valley is cut deeply into the resistant Gasconade Formation. Historically, the LTA was an oak woodland that graded into mixed-oak and mixed-hardwood forest in rougher lands. Today, it is a mosaic of pasture on smoother lands and dense second-growth oak forest and cedar thickets in ravines and on rougher lands. Dolomite glade/woodland complexes with high restoration potential exist. Several rare mussel species and bald eagle roosts and nests are associated with the Gasconade River. The LTA contains only small amounts of public land.

Tim Nigh

Named for the river it often overlooks, the Gasconade dolomite forms outstanding cliffs and caves throughout the Ozarks.

OZ8
MERAMEC RIVER HILLS SUBSECTION

(see map pg. 170–171)

GENERAL DESCRIPTION

The subsection consists of the hilly to rugged lands of the Meramec River basin. Steep slopes and narrow valley bottoms prevail everywhere. Soils are very cherty and range from very deep to thin over carbonate and sandstone bedrock. Local karst, losing streams, and large springs are characteristic. The Ordovician Roubidoux and Gasconade Formations and Cambrian Eminence and Potosi Formations underlie most of the ecoregion. Presettlement vegetation was a mixed-oak and pine-oak woodland and forest. Second-growth forests now dominate land cover, with cleared land only in valley bottoms and in less dissected areas. Large acreages are public lands.

LOCATION AND BOUNDARIES

This subsection lies in the northeastern Ozarks, completely on the northern side of the Ozark regional drainage divide. It comprises most of Crawford and Washington Counties and minor portions of Franklin, Jefferson, St. Francois, Iron, Reynolds, Dent, and Phelps Counties. The subsection is defined on the basis of deep dissection and moderately high local relief along the Meramec River and its tributaries. The western boundary with the Central Plateau is drawn to mark the change to less than 150 feet of local relief. This line is sharp through Crawford County but is much less so in Phelps and Dent Counties. The southern boundary with the Current River Hills is the Ozark regional drainage divide, here a sharp-crested ridge that separates the Meramec River and Black River drainages. The southeastern boundary with the St. Francois Knobs and Basins Subsection is drawn where the dissected landscape of narrow ridges and valleys of the Meramec River Hills changes to a landscape of sedimentary basins and igneous knobs; it is both a topographic and lithologic line. The northeastern boundary with the Inner Ozark Border Subsection is drawn where the Jefferson City–Cotter Formation becomes dominant, resulting in a lower-relief landscape of the Ozark Border. This boundary is transitional and is difficult to see in the landscape.

CLIMATE

Mean annual precipitation is 40–43 inches. The wettest months are May–July, and 57 percent of the annual precipitation occurs during the six warmer months of the year (at Sullivan). Annual snowfall averages 14–18 inches. Mean January minimum daily temperature is 19°. Mean July maximum daily temperature is 91° in the north but only 88° in the south because of the higher elevations. The growing season averages 210 days. Significant microclimatic variations occur locally because of the moderately high relief of the land.

TOPOGRAPHY AND GEOLOGY

The Meramec River Hills Subsection lies on the northern flank of the broad Ozark uplift. Strata dip gently northwestward, but they appear in any locality as horizontal.

The Meramec River is not only very scenic, but it also harbors one of the richest assemblages of fishes in North America.

Jim Rathert

The subsection is underlain by thick, cherty dolomites of the Cambrian Eminence-Potosi Formation and the thick, cherty dolomites and distinctive sandstones of the Ordovician Gasconade and Roubidoux Formations. The Roubidoux underlies the highest, least dissected parts of the landscape, while the Eminence-Potosi underlies the lowest and most entrenched narrow valleys; the Gasconade is in between. The dolomites are soluble and create impressive local karst, including some very large springs, extensive caverns, and numerous dry valleys. Surficial materials are clayey with numerous rock fragments, chiefly insoluble chert left behind as the dolomite dissolved. Local relief throughout the subsection is moderately high, 200–350 feet or more. The surface is thoroughly dissected into narrow ridges and sinuous valleys with steep slopes near the streams and broader ridges with moderately steep slopes farther back. Strip mining for barite has scarified large tracts of land in northeastern Washington County. Historic iron and lead surface mining also disturbed numerous scattered tracts of land and caused the denudation of thousands of acres of timber for fuel for smelting. Subterranean iron and lead mining continues and causes environmental concern.

SOILS

Soils are closely related to bedrock lithology and landscape position in this subsection. Soils that formed in residuum from the Roubidoux Formation are low in soluble bases such as calcium and magnesium. These soils include the Viburnum and Tonti series on interfluves. Tonti soils have a root-restricting fragipan in the subsoil. Backslope soils that formed in Roubidoux residuum include the very deep Coulstone and moderately deep Bender series, both of which are very cherty. Soils formed in residuum from the Gasconade and Eminence-Potosi Formations are higher in soluble bases. These soils include the Rueter and Hildebrecht soils on convex summits. Hildebrecht soils have subsoil fragipans. Backslopes include very cherty, red soils, such as the very deep Goss and Alred soils, and the moderately deep Sonsac soils. Shallow, loamy Moko soils are associated with glades in this subsection.

HYDROLOGY

The subsection lies entirely within the Meramec River drainage basin, including small parts of the upper basin of its main tributary, the Big River. Stream gradients are moderately steep to steep. Streams carry great bed loads of sand and gravel, and their channels are encumbered with gravel and sandbars with characteristic pool and riffle alternation. Little suspended sediment is carried by the streams. The Meramec River at Eureka has a mean discharge of 3,200 cubic feet per second. Natural streamflow is highest in spring and declines rapidly through the summer, except during periods of heavy or sustained rainfall. Flooding occurs naturally, since there are no flood-control structures of consequence in the drainage basin. Springs are numerous, including some very large ones along the Meramec River, and they provide significant amounts of base flow to the streams and mitigate against high seasonal fluctuations. The subsection lacks natural ponds and lakes, but numerous small lakes and ponds have been constructed for water supplies, stock watering, and to trap mining tailings. Water quality is generally good on the Meramec system, although it is subject to local pollution from built-up areas. Water quality of the Big River has been seriously degraded by runoff from mining residues. Springwater and groundwater in general tend to be abundant and of high quality, although high in alkalinity. The upland areas are karstic, and many stream channels on them are dry or losing streams.

TERRESTRIAL NATURAL COMMUNITIES

Historic. Before Euro-American settlement, this region was mainly timbered with oak and oak-pine forests and woodlands. Most of the timberlands were open and free of underbrush; only in the most rugged lands did dense cover of forest occur. The highest, smoothest lands were open-oak savanna. Shortleaf pine reached its northern extent in Missouri in this region, especially on the east where it extended well into Washington County. Bottoms were mainly well forested with mixed-hardwood and riverfront sycamore-cottonwood types. Dolomite glade/woodland complexes were common on steep slopes near the rivers.

Current. The region is still mainly timbered, except for cleared bottomlands and some ridges. However, the forests and woodlands have been altered by past management practices, including fire exclusion, and have become much more dense with a corresponding elimination of the rich woodland ground flora. Shortleaf pine is less abundant, and much of the forest is dominated by black and scarlet oak of nearly even age.

Major Natural Community Types

Post Oak, Black Oak, Scarlet Oak Dry Chert Woodland

Shortleaf Pine/Bluestem Dry Chert Woodland

Shortleaf Pine–Oak/Vaccinium Dry Chert Woodland

Mixed Oak–Hickory/Dogwood Dry-Mesic Chert Forest

White Oak/Dogwood Dry-Mesic Chert Forest

Red Oak–White Oak–Sugar Maple Mesic Dolomite and Bottomland Forest

Rare or Restricted Natural Communities. Numerous caves are present in the Meramec Hills, although often vandalized. Some outstanding dolomite cliff communities also occur. Few outstanding examples of oak or pine-oak woodland or forest are known. Most bottomland forests, especially mesic forests, have been replaced by pasture. Most glade/woodland complexes have been overgrown with cedar. Compared to the south, fens and sinkhole ponds are rare. The Meramec basin has very rich and unique stream communities.

Jim Rathert

The Courtois and Huzzah Creeks pour clear, spring-fed water into the Meramec River.

NATURAL DISTURBANCES

Fire, drought, and grazing by native ungulates maintained the open aspect of the timberlands. In their absence, encroachment by woody species has closed the timberlands. Flooding, including flash floods, occurs along streams; no major flood-control structures exist in the region.

RARE OR ENDANGERED SPECIES

The Meramec River Hills Subsection contains 273 records of 62 state-listed species. Many of the occurrences are associated with rivers and streams or caves, including numerous fish and mussel species. These include six species whose only occurrence in the state is from the Meramec River Hills: a micro caddisfly *(Leucotrichia pictipes),* Missouri glyphopsyche *(Glyphopsyche missourii),* bluff vertigo *(Vertigo meramecensis),* weakstock bulrush *(Schoenoplectus purshianus),* and two mosses *(Plagiomnium rostratum* and *Campylium polygamum).* Federally listed species known from the region include gray bat *(Myotis grisescens)* and Indiana bat *(Myotis sodalis).*

NATURAL AREAS

There are seven designated Natural Areas in the Meramec River Hills representing a wide variety of the features there. Examples of old-growth upland forest are at Meramec Upland Forest and Washington State Park Hardwoods; an old-growth bottomland forest occurs at Springs End Forest. Coonville Creek has fens and a unique calcareous seep-fed stream. Vilander Bluff is an outstanding dolomite cliff community. Finally, Indian Trail is a representative landscape with glades, woodlands, forests, and streams in a large complex mosaic.

PUBLIC LANDS

More than 230,000 acres of public land are in the Meramec Hills Subsection, an exceptionally high amount. Over 175,000 acres occur in the Salem-Potosi District of the Mark Twain National Forest. The Missouri Department of Conservation owns over 45,000 acres including Indian Trail, Woodson K. Woods, Huzzah, Little Indian Creek, Pea Ridge, and Meramec Conservation Areas. Several state parks, including Meramec, St. Francois, Washington, and Onondaga State Parks, total more than 12,000 acres in this subsection.

HUMAN GEOGRAPHY

Demographics. Indian activity (Osage, Shawnee, and others) was extensive in the subsection by farming, especially along the Meramec River, and burning of woodlands for hunting. Many trails crossed the region. Most of the early settlement was by creoles of French Canadian ancestry, their slaves, and Americans from Kentucky, Tennessee, and other parts of Appalachia, also with slaves. Mining later attracted a variety of other peoples, including immigrants directly from Europe. Population growth has varied. The best agricultural lands were taken well before the Civil War, but growth in the mining industries after the war kept population growing well into the twentieth century. In the twentieth century the rural parts, in general, have lost population. Some areas have experienced regrowth in active mining areas and from the recreation industry, especially along the major streams.

Economics and Land Use. French, with African Caribbean slaves, began surface lead mining around Old Mines and Potosi in Washington County around 1720. Their activity disturbed many acres of land and required extensive and repeated timber cutting for fuel. Many tracts were denuded of timber by the early nineteenth century. Iron mining began in the Meramec valley before 1820. The large Meramec ironworks near St. James (founded 1826) was responsible for denuding much land of its timber over its half-century of operation. Deep-rock lead mining at Viburnum (Iron County) began in 1960. Surface barite mining in Washington County began early in the nineteenth century and has continued since. All of these mining activities wrought significant effects on the environment. The first Americans who entered the Meramec valley around 1800 hunted, trapped, and began exploitation of the pineries of the basin. Some were miners, including the exploitation of saltpeter (potassium nitrate) from caves to make gunpowder. Permanent agricultural settlement was in place by the first decade of the 1800s at Potosi, Old Mines, and in the Big River valley. By 1830 agricultural settlement was in the Meramec River valley and its tributaries. It consisted of small fields in the alluvial bottoms and extensive open-range raising of cattle and hogs in the woodlands. Railroads brought change to this semisubsistent agricultural economy. Most of the land is now in forest or woodland. Major stream bottoms have pastures and limited amounts of cropland. Enormous acreages of land have been scarified by surface mining over the course of two and a half centuries. In the twentieth century submarginal farms were abandoned, croplands declined, and emphasis placed on hay and cattle raising. Likewise, the mining economy changed from individual, small-scale, mostly surface operations to large-company, large-scale, highly capitalized, deep-rock operations. Iron, barite, and lead mining continue as major activities in the subsection. Recreation and tourism also have grown around rivers and caves. The commercial and service sectors are strong along the I-44 corridor on the northwestern side and the Potosi–Bonne Terre areas, and these are the areas of fastest growth.

LANDTYPE ASSOCIATIONS

The Meramec River Hills Subsection is subdivided into eleven landtype associations (LTAs). Oak and pine-oak woodland dissected plains give way to oak woodland/forest hills and breaks nearer the rivers. The LTAs are illustrated on the maps and described on the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Meramec River Hills Subsection is part of one of the largest contiguous blocks of timber in the lower Midwest. This has important implications for the long-term survival of forest interior bird species and other forest-dwelling wildlife. It is also home to an exceptionally wide array of natural communities and rare species, many of them associated with the rivers and adjacent springs, cliffs, caves, fens, and forest communities. Public lands encompass a substantial portion of the region, but development pressure is increasing as the influence of St. Louis and local communities grows into the region. Long-term resource conservation will benefit from partnerships between public and private landowners to minimize fragmentation of resources by future development.

LANDTYPE ASSOCIATIONS IN THE MERAMEC RIVER HILLS SUBSECTION

(see landtype associations map pg. 170–171)

LANDTYPE ASSOCIATIONS IN THE MERAMEC RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ8a West Meramec River Oak Woodland/Forest Hills	The LTA occupies hills associated with the upper Meramec River and along the northwestern fringe of the basin. Most boundaries are drawn to separate the hills from adjacent dissected plains with less than 150 feet of local relief. The northeastern boundary with the Meramec River Oak Forest Breaks approximates a change to more rugged topography with over 250 feet of local relief.	The LTA consists of broad, rounded ridges associated with the Roubidoux Formation that give way to moderately steep slopes cut into the Gasconade Formation, and then to steep slopes in the Eminence-Potosi Formation adjacent to the Meramec River. Local relief ranges between 150 and 250 feet. Soils are mainly deep, cherty silt loams with occasional fragipan soils on ridges and shallow soils above bedrock on slopes throughout. Historically, oak woodland and forest communities were dominant with scattered areas of oak-pine woodland. Today, the landscape is almost entirely timbered in second-growth oak forest, except in the alluvial plains where pasture is common. Meramec Springs is located here, along with its numerous unique cave-dwelling species. I-44 and its associated towns skirt the entire northwestern fringe, and development associated with the interstate spills into this LTA.
OZ8b Cherryville Oak Savanna/ Woodland Plain	The LTA occupies a compact upland plain bisected by MO 19 south of Steelville in Crawford County. Boundaries are drawn to enclose the plain of less than 100 feet of local relief.	The LTA consists of the very slightly dissected plain between the Meramec River and Huzzah Creek. Local relief is less than 100 feet. The landform is karstic; the short streams are losing and ephemeral, and the LTA in general lacks perennial surface water. Fragipan soils formed in loess over Roubidoux residuum are common. Historically the karst upland was in oak savanna and woodland; today it is a nearly even mix of pasture and dense second-growth timber.
OZ8c Huzzah-Courtois Oak Woodland Dissected Plain	The U-shaped LTA occupies uplands on both sides of Huzzah Creek. Boundaries are drawn to mark the topographic transition to lands of greater relief (more than 150 feet) and to lands of less relief (less than 100 feet). The southern boundary is the Ozark regional divide.	The LTA consists of a dissected plain on several upland divides. Local relief is generally 100–150 feet, reaching 200 feet closer to the major streams and near the Ozark Divide. Slopes are generally moderate in steepness. Geologic parent materials and soils are quite variable, but much of the upland surface is formed on resistant materials of the Eminence-Potosi Formation. Historically, the LTA was in oak woodland and forest with scattered oak-pine woodland. Today, it is heavily timbered in second-growth oak forest with numerous pine plantations. Mining occurs at Viburnum and in the past occurred at other locations. Much of the LTA is in the Mark Twain National Forest and in state-owned lands.
OZ8d Meramec River Oak Forest Breaks	The LTA occupies the very rugged inner valley of the Meramec River, from above MO 8 on the Huzzah downstream to below Meramec State Park. Boundaries are drawn to identify the transition into a breaks landscape of more than 250 feet of local relief.	The LTA consists of rugged breaks with narrow ridges, steep slopes, and narrow, sinuous valleys; it represents the heart of the Meramec River Hills Subsection. Relief is over 250 feet and reaches 350 in a few places. The land bears the strong imprint of solutional processes. High cliffs, caves, springs, glade/woodland complexes, and outstanding forest communities are common. Numerous rare species sites are concentrated in this LTA. The LTA was historically and is currently covered in mixed-oak and mixed-hardwood forests. Most glade woodland complexes are overgrown and many bottoms are cleared pasture. Several state-owned lands are included in the LTA.
OZ8e Huzzah Oak Woodland/ Forest Hills	The LTA occupies the hills along Huzzah Creek from just above MO 8 upstream to MO 32. Boundaries are drawn to separate these hills with more than 150 feet of local relief from adjacent, lower-relief plains. The northern boundary marks the change to higher local relief in the Meramec River Oak Forest Breaks.	The LTA consists of moderately dissected hills with moderate to steep slopes. Local relief is mainly 150–250 feet with local areas near the creek up to 300 feet. Low cliffs are common. Most of the valley is cut into the Eminence-Potosi Formation, except for the northern end, where Roubidoux and Gasconade Formations dominate. One small igneous knob occurs in the upper valley. Historically and currently the LTA is timbered in oak and mixed-hardwood forest and woodland. Cleared bottomland pastures are common. The entire LTA is included within the Mark Twain National Forest.

LANDTYPE ASSOCIATIONS IN THE MERAMEC RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ8f Courtois Oak-Pine Woodland/ Forest Hills	The LTA occupies a variety of hill landscapes associated with the Courtois River and extending east across the headwaters of several tributaries to the Meramec and Big Rivers. The irregular boundaries are drawn to encompass upland landscapes within the range of shortleaf pine, mostly in Washington County.	The LTA consists of a moderately dissected upland lying in the watersheds of several stream systems. Broad ridges and moderate slopes grade into narrow ridges and steeper slopes near numerous stream valleys. Local relief is generally 150–250 feet with some areas near streams greater than 250 feet. The geologic pattern is a complex patchwork of areas dominated by the Eminence-Potosi Formation interspersed with many Roubidoux and Gasconade landscapes more typical of the eastern Ozarks. The LTA is historically and currently covered in pine, oak-pine, and mixed-oak woodland and forest, though the structure of second-growth timber today is much more dense and shaded. Significant amounts of cleared land occur in the headwaters of Brazil Creek. Most of the southern part of the LTA is in the Mark Twain National Forest, and state properties occur scattered in the northern part.
OZ8g East Meramec Oak Woodland/ Forest Hills	The LTA occupies the hills in the middle portion of the Meramec River, mostly in Franklin County, and hills in the adjacent basin of Indian Creek in Washington and Franklin Counties. Boundaries are drawn to encompass the hills landscape beyond the natural distribution of pine and to separate it from more rugged breaks to the west and plains to the east. The northern boundary marks the transition to hills of less relief on Jefferson City–Cotter dolomite of the Inner Ozark Border.	The LTA consists of broad ridges and moderate slopes that give way to narrow ridges and steeper slopes near the streams. Uplands underlain by the Roubidoux Formation have 100–200 feet of local relief, while deep valleys (200–400 feet) are cut into the Gasconade and Eminence-Potosi Formations. The LTA was heavily timbered in the historic past and still is in the present, mostly in oak woodland and forest with scattered glade/woodland complexes. Many of the bottoms are currently in cleared pasture. Several rare fish and mussel species are known from the Meramec River in this LTA. The northern part of the LTA is greatly affected by residential and commercial development associated with major highways and the St. Louis metropolitan area.
OZ8h Indian Prairie Oak Savanna/ Woodland Plain	The LTA occupies a weakly dissected upland between the Meramec and Big Rivers. Boundaries are drawn where local relief increases to more than 100 feet to separate the plain from the surrounding hills. The short boundary on the northeast is placed at the occurrence of the Jefferson City–Cotter Formation that is associated with the landscape of the Inner Ozark Border Subsection.	This small LTA is a compact upland plain with relative relief of less than 100 feet. It is underlain by the Roubidoux Formation in the north and the Eminence-Potosi in the south. Stream development is poor and surface water is relatively scarce. Historically, the LTA had small prairie openings in a landscape dominated by oak savanna and woodland. The small prairies may have been human-created or human-enhanced, since a large group of agricultural Shawnees lived nearby at the junction of Indian Creek and the Meramec River. Today, the cover is a mix of large blocks of pasture and second-growth oak forest. The southern part of the LTA has been severely scarified by surface barite mining by mechanization. MO 47 runs the length of the upland.
OZ8i Big River Oak Woodland/ Forest Hills	The LTA occupies the hills along the middle Big River and its Mineral Fork tributary. The western boundary marks a decline in relief and also the transition to lands within the natural range of pine. The eastern boundary is the change to a landscape of more rounded hill forms associated with the Jefferson City–Cotter Formation of the Inner Ozark Border. The southern border marks the change to a landscape on early Cambrian formations.	The LTA consists of broad ridges and moderate slopes farther from the rivers and narrow ridges and steeper slopes nearer the rivers. Local relief is everywhere greater than 150 feet and rises to more than 250 feet along the Mineral Fork. The LTA is underlain mainly by the resistant Eminence-Potosi Formation with some Roubidoux and Gasconade dolomites and sandstones in the north and early Cambrian limestones in the middle Big River valley. The LTA was historically and is currently largely timbered in oak woodland and forest, though second-growth forest today is more dense and compositionally altered. Valleys are often in cleared pasture. Numerous rare bat caves occur, especially in the lower part of the Big River. Surface lead and barite mining, earlier by hand-dug pits and more recently mechanically done, has scarified hundreds of acres of land in Washington County. Probably even more acreage has been repeatedly cut over for fuel for smelting.

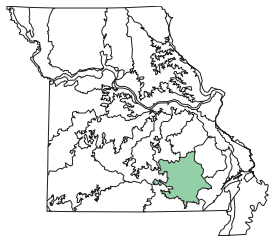
LANDTYPE ASSOCIATIONS IN THE MERAMEC RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ8j Clear Creek Pine-Oak Woodland Dissected Plain	The LTA occupies the upland divide slightly but thoroughly dissected by the headwaters of several tributaries to the Big and Meramec Rivers west and southwest of Potosi. Boundaries are drawn to encompass a dissected plains landscape with 100–200 feet of local relief. It is separated from the Potosi Plain on the east by the limit of natural pine range. The southern boundary is a straight fault line along which the land drops off very abruptly into a sedimentary basin of the St. Francis Knobs and Basins Subsection.	The LTA consists of a thoroughly but only moderately dissected upland plain from which streams drain radially into several drainage basins. The center is underlain by Roubidoux and upper Gasconade materials and has moderate slopes, and the Eminence-Potosi Formation is exposed on the edges. Local relief averages 100–200 feet. The LTA was historically in pine and pine-oak woodland (called "the pineries" by Henry Rowe Schoolcraft). Today it is nearly completely timbered in second-growth oak and oak-pine forest. The western half lies within the Mark Twain National Forest and is traversed by MO 21 and MO 8.
OZ8k Potosi Oak Savanna/ Woodland Plain	The LTA occupies the upland within the big bend of the Big River east of Potosi in east-central Washington County. The northern boundary is drawn where relief increases to more than 150 feet. The western boundary approximates the eastern limit of natural pine range. The southern boundary is a sharp change in geology.	The LTA consists of a dissected plain with less than 75 feet of local relief through most of it. Underlain by the Eminence-Potosi Formation, the LTA has rounded hill forms. Historically, the LTA was dominated by oak savanna and woodland. Today, it is in large blocks of dense second-growth oak forest interspersed with pasture and considerable numbers of rural, nonfarm residences. The LTA underwent extensive surface mining beginning around 1800 and bears the legacy in pits, mounds, coarse surficial materials and ruined soils, and repeatedly cut-over timber for fuel. The LTA is receiving increasing pressures for residential and commercial development.

Jim Rathert

The prothonotary warbler relies on wooded stream valleys, like those in the Meramec Hills Subsection, for its livelihood.

OZ9
CURRENT RIVER HILLS SUBSECTION

(see map pg. 172–173)



GENERAL DESCRIPTION

The Current River Hills Subsection consists of the hilly to deeply dissected portion of the Current, Black, and Eleven Point drainage basins. Gently rolling interfluves give way to steep slopes, narrow ridges, and narrow valley bottoms. Soils are rocky and formed mainly from carbonate and sandstone bedrock. Local karst, losing streams, and large springs are characteristic. Presettlement vegetation was mainly woodlands and forests of oak and shortleaf pine. Second-growth forests now dominate the landscape, with cleared land in valley bottoms. Much of the area is in public lands.

LOCATION AND BOUNDARIES

The Current River Hills Subsection lies in the southeastern Ozarks completely on the southern side of the Ozark regional drainage divide. It consists of the gently rolling to deeply dissected portions of the Current, Black, and Eleven Point drainage basins. The subsection comprises most of Shannon, Carter, and Reynolds Counties, the northern portion of Oregon County, and minor portions of Iron, Dent, Texas, Howell, Ripley, Wayne, and Iron Counties. It is defined on the basis of deep dissection and moderately high local relief along the Current, Black, and Eleven Point Rivers. Boundaries generally are located where the greater dissection and high local relief of this subsection drops to less than 150 feet in the surrounding less-dissected subsections. The eastern boundary with the St. Francois Knobs and Basins Subsection is defined on the presence of Precambrian and Cambrian rocks characteristic of that subsection. The northeastern boundary with the Meramec River Hills is the Ozark regional drainage divide and is not drawn on any change in relief or lithology. On the west and northwest the boundary is drawn to include within the Current River Hills the lower-relief Roubidoux sandstone dissected plain with its pine-oak woodland vegetation; this dissected plain extends down the divide between the Current and Eleven Point Rivers within the region.

CLIMATE

Mean annual precipitation is 43 inches in the north and 48 inches in the south. The wettest months are March–May and August, with 56 percent of the annual precipitation occurring during the six warmer months of the year (at Round Spring). Annual snowfall averages 10–14 inches. Mean January minimum daily temperature is 20–21°. Mean July maximum daily temperature is 89° in the north and 91° in the south. The growing season ranges from 207 days in the north to 220 days in the south. Significant microclimatic variations occur locally because of the high relief of the land.

TOPOGRAPHY AND GEOLOGY

The subsection lies on the southeastern flank of the broad Ozark uplift. Strata dip gently southward, but they appear in any locality as horizontal. The subsection is underlain by a variety of formations. High, gently rolling dissected plains and hills are underlain mainly by resistant sandstones and dolomites of the Roubidoux Formation. More deeply dissected lands are cut first into the dolomites of the Ordovician Gasconade Formation, and then, in the deepest valleys, into the Cambrian Eminence-Potosi Formation. Some of the higher ridges are underlain by the Ordovician Jefferson City–Cotter dolomite. All materials in the thick sequence of carbonate rocks are soluble and create karst topography, including some very large springs and caverns, sinkholes, box (blunt-headed) valleys, and dry valleys. Surficial materials are clayey with numerous rock fragments, chiefly insoluble chert left behind as the carbonate rocks are dissolved. The surface is thoroughly dissected with narrow ridges and valleys and steep slopes near the major rivers and broader ridges and valleys more distant from the rivers. Except on the highest, smoothest, loess-covered divides, the entire landscape, including river bottoms, is conspicuously mantled with rock fragments. Local relief throughout most of the subsection is high, 200–600 feet. A special tract of the subsection is defined by the partial erosional exhuming of Precambrian igneous knobs along the Current River. Here, a topography similar to that of the St. Francois knobs has been created, but to a much smaller extent. Historic copper mining in the igneous region caused the denuding of some tracts of timber for fuel. Deep subsurface lead mining occurs in the upper Black River basin and the potential for more lead mining is present.

Missouri Department of Conservation

The gray bat, a federally listed endangered species, hibernates in numerous caves in the Current River Hills Subsection.

SOILS

Soils are closely related to bedrock lithology and landscape position in this subsection. Soils formed in residuum from the Roubidoux Formation are low in soluble bases such as calcium and magnesium. These soils include the Viburnum and Tonti series on interfluves. Tonti soils have a root-restricting fragipan in the subsoil. Backslope soils that formed in Roubidoux residuum include the very deep Coulstone and Clarksville series and the moderately deep Bender series, all of which are very cherty. Soils formed in residuum from the Gasconade and Eminence-Potosi Formations are higher in soluble bases; these soils include the Rueter and Scholten soils on convex summits. Scholten soils have subsoil fragipans. Backslopes include very cherty, red soils such as the very deep Gooses and Laredo soils and the moderately deep Sonic soils. The shallow, clayey Gasconade soils are associated with glades in this subsection.

HYDROLOGY

The subsection lies within the Black River, the Current River (including its main tributary, the Jack's Fork), and Eleven Point drainage basins. Stream gradients are relatively steep. The Current River in central Shannon County drops 20 feet per mile. Streams carry great bed loads of sand and gravel, and their channels are distinguished by numerous gravel and sandbars. Streams carry very little suspended sediment and have a reputation for being exceptionally clear. Natural streamflow is highest in late winter and spring and declines during summer and early autumn. Flooding occurs naturally, including flash floods. There are no flood-control structures in the subsection, except for Clearwater Dam and Lake on the lower Black River. Springs, some of them huge in discharge (Big Spring has an average discharge of 440 cubic feet per second), are numerous, and they provide significant base flow for the streams. Seasonal fluctuation of rivers is mitigated by these immense quantities of spring discharge. The subsection lacks natural lakes and ponds, except for sinkhole ponds. Ponds have been constructed for stock watering. Fens are common. Runoff from lead-mining activity in the upper Black River basin may pose a risk to water quality. Water quality in general is very good, except when intense usage of the rivers by recreationists in summer may cause pollution. Groundwater in general tends to be abundant and of high quality, although high in alkalinity. Many stretches of smaller headwater stream channels have low gradients and are dry or losing streams (locally called "sinking streams") that provide water for resurgence elsewhere as springs.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The Current River Hills and its wide variety of habitats supported a diversity of vegetation types. The region has always been timbered. It was best known for the extensive shortleaf pine–oak forests and woodlands that supported an exceptional timber boom at the turn of the twentieth century. Open-oak and pine woodlands with bluestem grass occupied higher, gentler ground and steep

exposed slopes. Closed forests of oak, shortleaf pine, and mixed deciduous species were best developed on the roughest, most dissected lands. Dolomite glades frequently occurred as openings in the forest. Unique igneous glade, oak woodland, and oak forest communities occupied the igneous knobs in the central Current River valley. Fens and sinkhole ponds added to the diversity of the region.

Current. The region, except for pastured bottoms, is still timbered. The region is at the center of the largest block of forest in the Ozarks and one of the largest in the Midwest. This has important implications for wildlife species requiring forest interior habitats. In addition, the region supports a substantial timber industry. Forest composition and structure has changed, with less shortleaf pine and a uniformly younger forest replacing the variable woodland/forest mosaic. Glade openings are now largely overgrown by eastern red cedar; many fens and sinkhole ponds have been drained or are otherwise altered. However, a significant component of this landscape is still in native vegetation.

Major Natural Community Types

Shortleaf Pine/Bluestem Dry Chert and Igneous Woodland

Shortleaf Pine–Oak/Vaccinium Dry Chert and Igneous Woodland

Chinquapin Oak–Ash (Eastern Red Cedar)/Little Bluestem Dry Limestone Dolomite Woodland

Mixed Oak–Hickory/Dogwood Dry/Mesic Chert and Igneous Forest

White Oak–Mixed Oak/Redbud Dry-Mesic Limestone/Dolomite Forest

Red Oak–White Oak–Sugar Maple Mesic Dolomite and Bottomland Forest

Rare or Restricted Natural Communities. Rare and unusual community types such as caves, springs, fens, and sinkhole ponds are relatively common in this region; numerous examples of each occur. High-quality glades, oak and oak-pine woodlands and forest, and bottomland forest communities are rare, but substantial restoration potential exists.

NATURAL DISTURBANCES

Fire and, to a lesser extent, grazing played an important role in maintaining the open woodlands and glades of the historic uplands; most have become dense or overgrown in their absence. Wind and ice damage, as well as flooding, continue to play a role in shaping forest composition and structure.

RARE OR ENDANGERED SPECIES

The Current River Hills Subsection is exceptionally rich in rare or endangered species. The Heritage Database lists over 700 occurrences of 172 species in this subsection. Over 30 species are mainly restricted to this subsection, and most of these have fewer than five populations. These restricted species include numerous Pleistocene relict plants associated with north-facing bluffs and fens, as well as species restricted to sinkhole ponds, springs, and streams. These habitats and caves are strongly associated with all listed species in the region. Species of federal concern include gray and Indiana bats *(Myotis grisescens* and *M. sodalis),* Curtis' pearly mussel *(Epioblasma florentina* var. *curtisi),* and pink mucket *(Lampsilis abrupta).*

NATURAL AREAS

The great variety of natural features and large amount of public land support numerous Natural Areas. They are listed below by principal feature.

Representative Landscapes: Jack's Fork, Stegall Mountain, The Sunklands

Upland Forests: Big Spring Pines, Current River, Golden Seal, Montauk Upland Forest, Pioneer

Bottomland Forest: Big Barren Creek, Tunnel Bluff Woods

Igneous Glade: Mill Mountain

Dolomite Glade: Mule Hollow Glade

Streams: Rogers Creek at Stegall Mountain

Caves: Powder Mill Cave

Springs: Big Spring, Blue Spring

Cliffs: Barn Hollow

Fens: Blair Creek Raised Fen, Grasshopper Hollow, Husman Fen, Wells Branch Fen

Sinkhole Ponds: Brushy Pond, Cupola Pond, Gilmore Pond, Grassy Pond, Lily Pond, Red Maple Pond, Tupelo Gum Pond

Other Geologic Features: Cardareva Bluff, Triple Sink

PUBLIC LANDS

This scenic and ecologically important region contains a high concentration of public lands. Almost 800,000 acres are distributed among three districts of the Mark Twain National Forest, parklands of the Ozark National Scenic Riverways, numerous Conservation Areas of the Missouri Department of Conservation, lands of the U.S. Army Corps of Engineers, and Montauk State Park. Included within the Mark Twain National Forest are the Eleven Point National Scenic River and the Irish Wilderness.

HUMAN GEOGRAPHY

Demographics. Indians had settlements and hunted throughout the Current River Hills long before Americans entered. They fired the forests and woodlands. In the early nineteenth century several westering Indian groups (Shawnee, Delaware, and Cherokee) also lived for short periods in the subsection. The first Americans of the 1820s and 1830s were hunters, trappers, Indian traders, and, in the Eminence area, copper miners. They were succeeded by permanent settlers with a subsistence farm economy. These farmers had small patches of cropland in the creek bottoms and used the open woodlands for open-range cattle and hog raising. They also burned timberlands. The farmable bottomlands, very restricted in extent, were mostly occupied by the 1860s. The Civil War caused population loss and abandonment of cleared and improved lands. Toward the end of the century large-scale timber exploitation for pine and hardwoods began and continued until the natural supply was exhausted in the 1920s. Lumber and railroad crossties were major products. The early American settlers were old-stock Americans chiefly of Scotch-Irish ancestry, who emigrated from Tennessee and adjacent parts of Appalachia. Their settlements were sparse and strung out in the narrow valleys. Population grew slowly until the lumber era, which brought in a variety of people. After that era, a pronounced population decline set in and continued until the 1970s when it stabilized and started to rise slowly. Population, however, is still very much less than what it was before mid-twentieth century.

Economics and Land Use. General farming returned after the lumber period, but it was unsuccessful and has since been almost completely given up. Virtually all the land is in forest or woodland with the remainder in pasture in stream valleys and some broader ridges. Livestock grazing continues on some better lands, as in the stream valleys of the Black River system. The economy depends largely on forest products and a recreation and tourism industry built around the subsection's streams, caves, and springs. Subsurface lead is mined in the northeastern parts of the subsection, and the potential for more exists elsewhere in the region. There is very little commercial and industrial economic development, although recreational and tourism activities continue to increase.

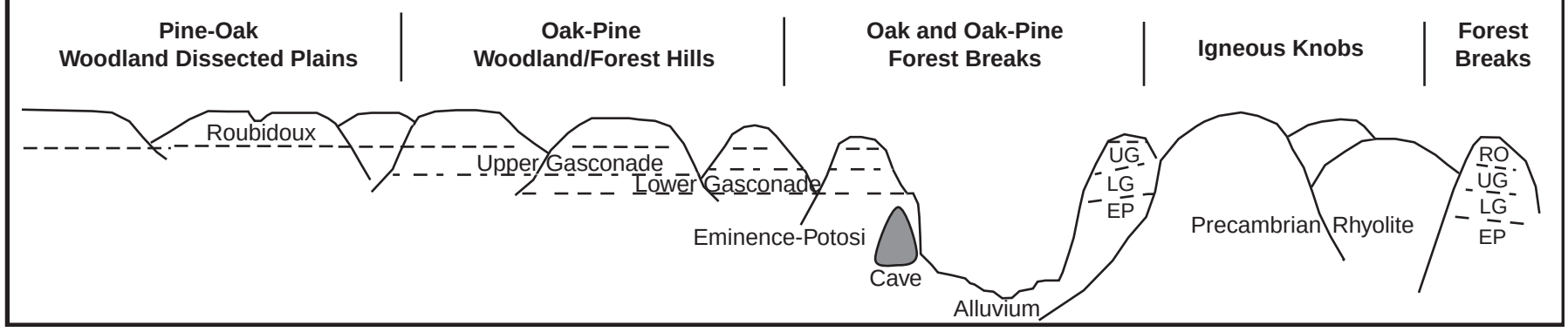
LANDTYPE ASSOCIATIONS

The Current River Hills Subsection is subdivided into nine landtype associations (LTAs). Gently rolling pine-oak woodland dissected plains on interfluve uplands give way to oak-pine hills, then rugged oak forest breaks. In addition, a cluster of Precambrian igneous knobs occurs in the center of the region. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Current River Hills Subsection is in the heart of one of the largest contiguous blocks of timber in the upper Midwest. This has important implications for the long-term survival of forest interior bird species and other forest-dwelling wildlife. It is also home to an exceptionally wide array of natural communities and rare species, as well as three nationally significant rivers. Public lands encompass a high percentage of the region and afford ample opportunity for resource conservation as well as for public use of these outstanding resources.

LANDTYPE ASSOCIATIONS IN THE CURRENT RIVER HILLS SUBSECTION



(see landtype associations map pg. 172–173)

LANDTYPE ASSOCIATIONS IN THE CURRENT RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ9a Current River Pine-Oak Woodland Dissected Plain	The LTA is located in several separate tracts along the periphery of the Current River valley and in separate tracts on the divides between it and the Black and Eleven Point Rivers where the Roubidoux Formation has been only moderately dissected. Boundaries are drawn to include the dissected plains on the Roubidoux Formation with local relief of 50–150 feet.	The LTA consists of a moderately dissected upland plain associated with the Roubidoux Formation. Relief over large tracts averages less than 100 feet but increase towards the river margins. Karst occurs in several areas. The LTA was historically and is currently covered in pine and pine-oak woodland and forest associated with sandy soils. It also includes many unique sinkhole pond communities.
OZ9b Current River Oak-Pine Woodland/Forest Hills	The LTA is located on both sides of the Current and Jack's Fork Rivers, where highly dissected lands occur. Boundaries are drawn where relief declines to less than 150 feet in dissected plains and where relief increases to more than 250 feet in rugged breaks. The northeastern boundary with the Black River Hills follows the drainage divide between the Current and Black Rivers.	The LTA consists of the strongly rolling to hilly lands associated with much of the Current River valley. Local relief averages 150–250 feet. Slopes are steep and there is very little flat land either on ridgetops or in valley bottoms. The LTA was historically covered in oak and oak-pine woodland and forest on soils that are mainly cherty and low-base that are associated with the Roubidoux and Gasconade Formations. Today the region is dominated by second-growth oak and oak-pine timber that is not as open as formerly. The LTA receives little development pressure except by recreation at Eminence and Van Buren. Much of the LTA is in the public land of the Mark Twain National Forest, the National Park Service, and the Missouri Department of Conservation. The LTA is very similar to the Eleven Point Oak-Pine Woodland/Forest Hills and the Black River Oak-Pine Woodland/Forest Hills.
OZ9c Eleven Point Oak-Pine Woodland/Forest Hills	The LTA occupies the hilly, thoroughly dissected lands on both sides of the Eleven Point River, mostly in Oregon County. Boundaries are drawn at the break in landforms and relief between flatter, dissected plains with less than 150 feet of relief (on both the northern and southern sides) and the more rugged breaks with over 250 feet of local relief (adjacent to the Eleven Point).	The LTA consists of the strongly rolling to hilly lands with moderate slopes associated with the Eleven Point River valley. The LTA was historically covered in oak and oak-pine woodland and forest on cherty, low-base soils associated with the Roubidoux and Gasconade Formations. Today it continues the same cover but with less openness and more second-growth timber. About half of the LTA is within the Mark Twain National Forest. The LTA is very similar to the Current River Oak-Pine Woodland/Forest Hills and the Black River Oak-Pine Woodland/Forest Hills.
OZ9d Black River Oak-Pine Woodland/Forest Hills	The LTA occupies much of the Black River basin where the lands are moderately to steeply dissected. Boundaries are drawn where landforms and relief change to flatter, dissected plains with less than 150 feet of relief (on the Black-Current drainage divide) and to the more rugged breaks with over 250 feet of local relief. The boundary with the Current River Hills follows the drainage divide. The northern boundary is the drainage divide with the Meramec River basin.	The LTA consists of strongly rolling to hilly lands with steep slopes. Virtually the whole landscape is in steep hillslopes with the only flat land in river and creek bottoms. Many of the streams are losing streams. Historically, the LTA was in oak and oak-pine woodland and forest on mainly cherty, low-base soils associated with the Roubidoux and Gasconade Formations. Currently an oak and oak-pine woodland and forest still dominate, but the woodlands have less openness due to fire suppression and the forests are second-growth. In contrast to other "hills" LTAs of the subsection, there are more higher-base soils derived from the Eminence-Potosi Formation. The far northern and far southern parts of the LTA are in the Mark Twain National Forest. The LTA is similar to the Current River Oak-Pine Woodland/Forest Hills and the Eleven Point Oak-Pine Woodland/Forest Hills.

(table continued on pg. 128)

LANDTYPE ASSOCIATIONS IN THE CURRENT RIVER HILLS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ9e Current River Oak Forest Breaks	The LTA occupies the rugged central part or heart of the Current River valley across the length of Shannon County with a small outlier south of Van Buren at Big Spring. Boundaries are drawn to encompass lands with higher relief (more than 300 feet), narrow ridges, and sinuous valleys and that are underlain by the Eminence-Potosi Formation.	The LTA consists of the rugged, steeply sloping land in the middle of the Current River valley. Local relief is 250–500 feet or more. Narrow ridges, steep sideslopes, and narrow, sinuous valleys with high, bold cliffs characterize the LTA. Valleys have the Roubidoux Formation on their upper slopes, the Gasconade dolomites in midslopes, and the Eminence-Potosi dolomites at lowest elevations. The LTA is known for many huge springs. The variety of substrates, elevations, and exposures support a variety of soil environments and vegetation types, chiefly oak forests. Outstanding springs, streams, cliffs, caves, fens, glades, and forest communities are present. The LTA receives heavy impact from recreational use of the Current River. Most of the LTA is in public lands.
OZ9f Jacks Fork Oak-Pine Forest Breaks	The LTA occupies the narrow, rugged, central part or heart of the Jack's Fork River valley and could be considered an extension of the Current River Oak Forest Breaks (OZ9e). Boundaries are drawn to encompass lands with more than 250 feet of local relief.	The LTA consists of deeply dissected hills with local relief of 250–400 feet. Narrow ridges, steep sideslopes, and narrow, sinuous valleys are cut mainly in the Roubidoux and upper Gasconade Formations. Many sizeable springs occur in the valley. Oak-pine and mixed-oak timber types dominate the LTA. Soils are mainly cherty, low-base soils. Outstanding springs, streams, cliffs, caves, fens, glades, and forest communities are characteristic. The LTA is significantly affected by recreational use of the Jack's Fork River. Most of the LTA is public land.
OZ9g Eleven Point Oak-Pine Forest Breaks	The small LTA occupies a narrow belt of rugged land along the Eleven Point River in northeastern Oregon County. Boundaries are drawn to encompass a landscape of narrow ridges and sinuous valleys with relief higher than 250 feet.	The LTA consists of deeply dissected hills with narrow ridges, steep sideslopes, and narrow, sinuous valleys with very little flat land except in small patches along the river. Local relief is 250–400 feet or more. Hills are cut mainly in the Roubidoux and upper Gasconade Formations. Oak-pine and mixed-oak timber types occur on the mainly cherty, low-base soils derived from these formations. Outstanding springs, streams, cliffs, caves, fens, glades, and forest communities are present. Virtually all of the LTA is public land.
OZ9h Black River Oak Forest Breaks	The LTA occupies a belt of rugged land along the Black River (including its West Fork) above Clearwater Lake. Boundaries are drawn where relief decreases to less than 250 feet. The boundary on the east side is drawn where the igneous landscape of the St. Francis Knobs and Basins Subsection begins.	The LTA consists of deeply dissected land with narrow ridges, steep sideslopes, and narrow, sinuous valleys cut mainly into the Eminence-Potosi Formation. Virtually all the land is in steep slopes; only small patches of bottomland occur along the Black River. Local relief is 250–400 feet or more. Oak and mixed-hardwood forests dominate the landscape. Outstanding springs, streams, cliffs, caves, fens, glades, and forest communities are characteristic. The northern part lies within the Mark Twain National Forest. The southern end includes Clearwater Lake and lands of the U.S. Army Corps of Engineers.
OZ9i Eminence Igneous Glade/Oak Forest Knobs	The LTA is located mainly on the southwestern side of the middle Current River, 5 miles east of Eminence and below the junction of the Jack's Fork. Boundaries are drawn to enclose approximately twenty igneous knobs and adjacent dolomite basins.	The LTA consists of a collection of high, broadly rounded igneous knobs rising to different elevations. Local relief is as high as 600 feet, including steep rises from the Current River. Prominent igneous glade and woodland communities encircle the knob tops, while sideslopes are in mixed-oak timber. Broad dolomite basins and narrow, scenic shut-ins on igneous rock occur between the knobs. Much of the area is in public land.

Tim Nigh

A ring of swamp tupelos surrounds Tupelo Gum Pond in Oregon County.

OZ10
ST.FRANCOIS KNOBS AND BASINS SUBSECTION

(see map pg. 180)

GENERAL DESCRIPTION

The St. Francois Knobs and Basins Subsection is distinctive for the presence of bedrock of Precambrian age that resulted from ancient volcanic activity and by bedrock of Cambrian age that fills in spaces among and around the Precambrian areas. The subsection has three different topographic expressions. One is a congeries of rounded, smooth-sided igneous knobs and hills that rise conspicuously to different elevations. Another is intervening smooth-floored basins and valleys on dolomites and sandstones. The third is tracts of thoroughly dissected topography typical of surrounding sedimentary hills subsections of the Ozark Highlands but geographically associated with the other two topographies. Local relief reaches close to 1,000 feet but more commonly is 400–700 feet. Presettlement vegetation was a mixture of forests, open woodlands, glades, and small prairies in the basins. Most of the more rugged portions of the subsection are wooded, and extensive acreages are in public lands. Exceptionally large areas of igneous glade and woodland complexes remain. Pastures and grazed woodlands occupy the basins and valleys. Lead mining has scarified the land extensively.

LOCATION AND BOUNDARIES

The subsection lies in the eastern Ozarks of southeastern Missouri. It comprises the larger portions of St. Francois, Madison, and Iron Counties and minor portions of Washington, Reynolds, Wayne, Bollinger, and Ste. Genevieve Counties. Its boundary is drawn to encompass all of the major Precambrian surfaces of southeastern Missouri (except an isolated area in Shannon County), which necessitates the inclusion of large areas of early Paleozoic sedimentary rock mixed among the Precambrian igneous materials. Cambrian strata generally form the basins and Precambrian rock the knobs of the section, whereas Ordovician and later strata form the dissected hills of the surrounding subsections. This definition of the boundary is least successful in the southern parts, where the geographic pattern of rock type, age, and topography is most complex.

CLIMATE

Mean annual precipitation ranges from 42 inches in the north to 46 inches in the south. The wettest months are March–May and November, and the driest months are January–February. The six warmer months of the year account for 55 percent of the precipitation (at Arcadia). Annual snowfall averages 14 inches. Mean January minimum daily temperature is 19–21°, and mean July maximum daily temperature is 90°. The growing season is 205–210 days. Because of the high relief of this subsection, microclimatic variations may be significant within very short distances.

TOPOGRAPHY AND GEOLOGY

The subsection lies at the structural center of the Ozark dome. Billion-year-old Precambrian igneous rocks ("basement rocks") have been uplifted, and, after hundreds of millions of years of erosional removal of overlying strata, are now exposed at the surface. These exhumed igneous rocks consist of batholithic granites into which were intruded rhyolites and other volcanics. The result is a mixture of igneous rock types, all of which are resistant to erosion and stand out as high elevations in the landscape. Although all knobs are broad and rounded, slopes on rhyolites are noticeably steeper than those on granite. All igneous slopes are rock-mantled. The igneous knobs are often interconnected by early Cambrian sedimentaries that formerly covered the igneous rocks and now represent remnants of the incomplete removal of the sedimentary cover. These Cambrian strata consist of the LaMotte sandstone, Bonne Terre dolomite, and Potosi and Eminence cherty dolomites. The sandstone and cherty dolomites are associated with hilly terrain and the chert-free dolomites are associated with smooth plains in the basins between the igneous knobs. Local relief among the knobs is 300–1,000 feet, on the dolomite plains 100–200 feet, and in the sandstone and cherty hills 200–300 feet. Distinctive topographic portions of the subsection have special geographic names (Farmington Plain, Bellevue Valley, Arcadia Valley, Fredericktown Basin, etc.) and most of the knobs have names (Taum Sauk, Pilot Knob, Mud Lick Mountain, etc.). The subsection contains valuable mineral deposits including lead, iron, manganese, silver, cobalt, and dimension stone (granite). Surface lead mining has scarified the surface for two and a half centuries, and thousands of acres of forests and woodlands have been denuded, sometimes repeatedly, for fuel for smelting. Lead is thought to contaminate many streams and soils.

SOILS

Soils are closely related to the bedrock lithology and landscape positions within the subsection. Within the igneous bedrock areas, soils are mostly moderately deep and acidic, with low amounts of soluble bases such as calcium and magnesium. Knobtop soils are commonly on summit positions, with the very cobbly Irondale soils on shoulders and the loamy, bouldery Syenite soils on backslopes. The very shallow Taumsauk soils are in igneous glades. Soils formed in limestone residuum include the very cherty Wilderness soils on summit positions, with root-restricting fragipans. The very deep, cherty red Clarksville soils are typical on backslopes. The soils in plains and basins are generally very deep, with reddish, silty clay loam subsoils, such as the Crider, Fourche, and Courtois series.

HYDROLOGY

Lying topographically high at the structural center of the Ozark uplift, this subsection is the source region for streams that radiate outward in several directions. The St. Francis River, whose basin is the largest one of this subsection, drains the south-central portion of the subsection. The Castor River also leads southward on the eastern boundary. The south-flowing Black River system has its headwaters on the western side of this subsection. The Big River, the largest tributary of the Meramec, drains to the north. Most of the streams have reaches that pass through rock-defended narrows, or "shut-ins," where the streams drop steeply in short distances over resistant igneous bedrock. Stream gradients in general are steep, and water velocities are high. Channels carry coarse bed loads of gravel and sand, but very little suspended load. Springs are common, but the large springs common elsewhere in the Ozarks are absent. The subsection had no natural lakes, but several small lakes have been constructed for residential developments and water supplies. Taum Sauk Reservoir, a unique lake built for pumped-storage hydroelectricity generation, occupies the top of Proffit Mountain. Lakes also have been created to impound and settle out tailings from lead mines. Ponds for stock watering are in the cleared basins. Streams reach their average annual peak discharge in spring, then decline quickly to a late summer and autumn low. Flash floods occur from high intensity rains on thin soils on steep slopes. Water quality tends to be high, except where water is affected by lead mining and urbanization. Subsurface water is not abundant in the igneous-rock portions of the subsection, but somewhat more so in sedimentary regions, where it is moderately high in alkalinity.

TERRESTRIAL NATURAL COMMUNITIES

Historic. Forest, woodland, glade, and cliff communities on igneous substrates characterize this subsection and no other in the Ozarks. Oak and oak-pine forests and woodlands dominated the landscape before Euro-American settlement. Igneous glades and open-oak woodlands occupied the tops and exposed slopes of the igneous knobs. Shortleaf pine–oak forests and woodlands mainly occupied the sedimentary hills and ridges. Basin areas were forested or had scattered, open

Polished granite forms a shut-ins at Castor River Natural Area in Madison County.

Jim Rathert

limestone glade/woodland complexes, even small prairies, on shallow soils. Timbered areas throughout varied in their density and susceptibility to fire.

Current. The diversity of physical conditions still supports a wide variety of natural communities. Most of the rougher lands are still timbered in second-growth oak and oak-pine forest. Composition and structure has been altered by past management; shortleaf pine has diminished in extent. Igneous glades and woodlands have slowly closed in without fire to maintain them. Efforts to restore these communities with prescribed fire are occurring on public lands. Basin areas are largely nonnative pasture or cropland.

Major Natural Community Types

Ozark Igneous Glades

Post Oak–Blackjack Oak/Bluestem Dry Igneous and Chert Woodland

Post Oak, Black Oak, Scarlet Oak Dry Igneous and Chert Woodland

Mixed Oak–Hickory/Dogwood Dry-Mesic Igneous and Chert Forest

White Oak/Dogwood Dry-Mesic Igneous and Chert Forest

Shortleaf Pine–Oak/Vaccinium Dry Igneous and Chert Woodland

Chinquapin Oak–Ash (Eastern Red Cedar)/Little Bluestem Dry Limestone Dolomite Woodland

White Oak, Mixed-Oak/Redbud Dry-Mesic Limestone/Dolomite Forest

Rare and Restricted Natural Communities. Igneous glades, woodlands, forests, cliffs, and streams are essentially confined to this subsection. Though they have changed in the absence of fire and by livestock grazing, numerous high-quality examples remain. Limestone glades and woodlands associated with the basins are extremely rare. Fens, now mostly drained and pastured, are also rare communities. Unique sandstone communities, especially cliffs, are associated with the LaMotte sandstone on the eastern border of the subsection.

NATURAL DISTURBANCES

Fire and drought were natural forces important in shaping and maintaining glades and open woodlands. Many have succeeded to closed conditions in the absence of fire.

RARE OR ENDANGERED SPECIES

The subsection has 173 records for 90 state-listed species. Many of the species are associated with the streams of the region. Other important habitats include cliffs, fens, igneous glades, and bottomland forests. Most species are in the igneous knobs and many are associated with existing public land. Several species are confined principally to this subsection in Missouri; they include the Big Creek crayfish *(Orconectes peruncus),* northern arrowwood *(Viburnum recognitum),* a millipede *(Zosteractus interminata),* and three mosses. Federally listed species within the subsection include Indiana bat *(Myotis sodalis),* gray bat *(Myotis grisescens),* Mead's milkweed *(Asclepias meadii),* and running buffalo clover *(Trifolium stoloniferum).*

NATURAL AREAS

Outstanding igneous features are protected at St. Francois Mountains, Hughes Mountain, Buck Mountain, Elephant Rocks, Castor River Shut-Ins, Royal Gorge, Johnson's Shut-Ins, and Mudlick Mountain Natural Areas. Johnson's Shut-ins Fen and Johnson's Shut-Ins Dolomite Glade contain examples of a fen and limestone glade respectively.

PUBLIC LANDS

The subsection has more than 140,000 acres of public land. A majority of these lands are part of the Mark Twain National Forest, including Bell and Rock Pile Mountain Wilderness Areas. Public lands are also in Conservation Areas of the Missouri Department of Conservation (Buford Mountain, Buck Mountain, and Proffit Mountain Conservation Areas) and Missouri State Parks (Sam A. Baker, Taum Sauk, and St. Joe State Parks). Most of the public lands are in the igneous knobs areas.

HUMAN GEOGRAPHY

Demographics. Resident Indians made use of this region primarily for hunting. Eastern Indians who were moving west temporarily occupied the region in the early 1800s. French, with African Caribbean slaves, began surface mining at Mine la

Richard Thom

Hughes Mountain Natural Area in Washington County preserves an unusual occurrence of polygonally jointed igneous rock called "devil's honeycomb."

Motte, north of Fredericktown, around 1720; this activity disturbed many acres of land and required extensive timber cutting for fuel around every smelting site. Surface lead mining began at Flat River and Bonne Terre in St. Francois County just before 1800. Iron was mined and smelted in some basins before 1820. Agricultural settlement by Americans began in many basins of the subsection around 1800. The usable land was fully occupied by 1860. The people who settled the subsection in the nineteenth century were old-stock Americans, chiefly of Scotch-Irish and English ancestries, who immigrated from Tennessee and Appalachian Carolina. Immigration essentially stopped by the Civil War, except for labor attracted to the lead mining industry, much of which was European immigrant labor. Rural parts of the region reached their maximum population early in the twentieth century and have been losing population since. Many relatively isolated valleys were nearly depopulated. Towns, however, have grown largely due to increased mining and commercial opportunities. In general, population is growing slightly in the subsection.

Economics and Land Use. The knobs have never been farmed, although they have been grazed. Historically, farming has consisted of small fields or patches of cultivated crops, with woodlands and timber used for open-range cattle and hog raising. Basin areas are largely pastureland. Deep subterranean lead mining began shortly after the Civil War when the diamond-bit drill was introduced and railroads provided access. Production and scale of operations increased immensely, and the subsection became the world's largest producer of lead in the twentieth century. Exhaustion of the ore and discovery of large deposits to the west led to a closure of all lead mines in St. Francois County in the 1960s. Timber cutting for lumber and railroad ties peaked around the turn of the century. Coal replaced wood and charcoal for fuel in the metal industry before the turn of the century. There is a minor timber industry for pallet, flooring, and charcoal today. Open-range grazing no longer exists. Urban land use is limited, except around Park Hills, Farmington, Fredericktown (all in the US 67 corridor), and Ironton. More recently, the subsection has attracted recreationists and retirees who have sought out lake developments and remote valleys. However, a summer resort function had been in place in the Arcadia Valley since the 1880s, when railroads first penetrated the region. The economic structure is based largely on stock raising, timber industries, tourism and recreation, and some mining.

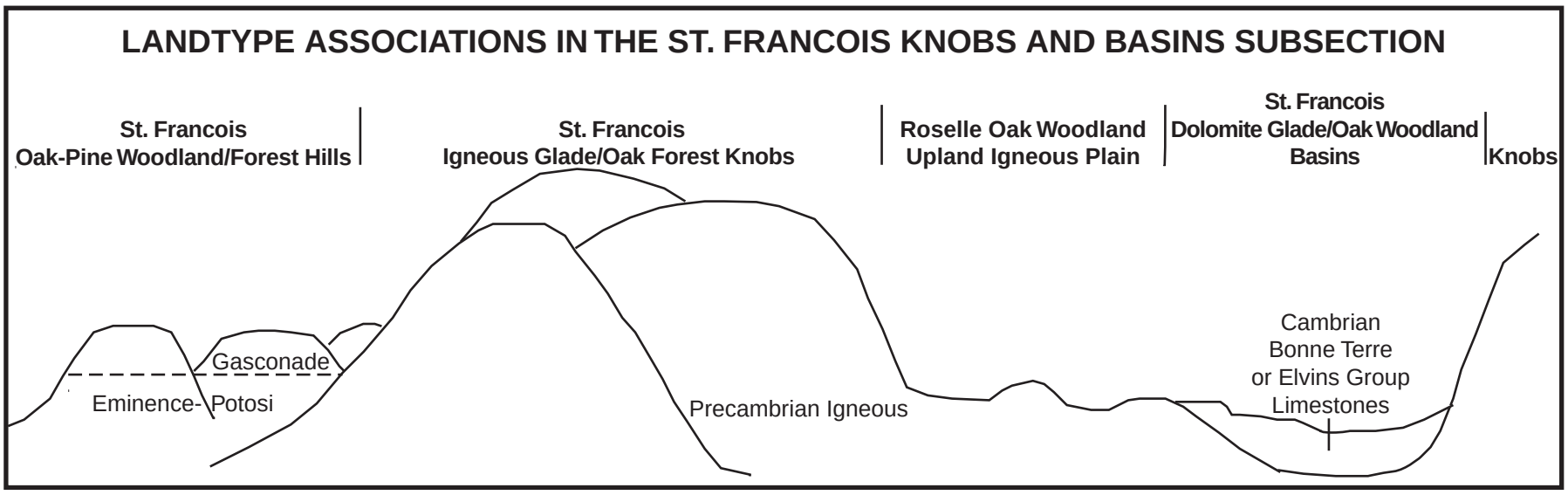
LANDTYPE ASSOCIATIONS

The St. Francois Knobs and Basins Subsection is subdivided into four landtype associations (LTAs). The most prominent LTAs are the ones with igneous knobs and basins. There is also an unusual elevated igneous plain and an LTA with sedimentary hills. LTAs are illustrated on a map and described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

While the unique igneous features of the region are well represented on public lands, there are opportunities to consolidate and connect them through further acquisition or voluntary landowner-incentive programs. Particularly important are the unique stream resources with their numerous rare species. In addition, continued and expanded use of prescribed fire will enhance the igneous glade and woodlands indigenous to the region. The sedimentary hills and basins are poorly represented by current conservation lands. The high interest in outdoor recreation in the region that already exists might be enhanced by increased education about the unique attributes of the St. Francois ecoregion.

LANDTYPE ASSOCIATIONS IN THE ST. FRANCOIS KNOBS AND BASINS SUBSECTION



(see landtype associations map pg. 180)

LANDTYPE ASSOCIATIONS IN THE ST. FRANCOIS KNOBS AND BASINS SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ10a St. Francois Igneous Glade/ Oak Forest Knobs	The LTA occupies a large area of igneous knobs in the center of the subsection and seven small clusters of knobs dispersed throughout the subsection. Boundaries are drawn to encompass the knobs and associated igneous surfaces. Boundaries are usually obvious and discreet breaks in the landscape.	This LTA consists of prominent, broadly rounded knobs that rise 500–600 feet above flat interknob basins. Gently rounded knob summits give way to moderately to very steep, boulder-strewn sideslopes. Narrow shut-ins of streams on igneous rock are common. The knobs are composed of Precambrian rhyolite and granite, and the basins are underlain by Cambrian sandstones, limestones, and dolomites. Soils on the upper slopes and tops of rhyolite knobs consist mainly of shallow to moderately deep, cobbly loams. Very deep, cherty silt loams predominate on the sedimentary areas between the knobs. Streams flowing on top of the igneous substrates have characteristics unique to Missouri. The LTA is still largely timbered in mainly mixed-oak woodland and forest communities interspersed with frequent igneous glades. Much of the LTA is in various types of public lands.
OZ10b St. Francois Dolomite Glade/ Oak Woodland Basins	The LTA occupies two large basins, a large one in the northern part of the LTA that includes Fredericktown, Farmington, Park Hills, and Bonne Terre, and a much smaller one in the south at Patterson south of Mudlick Mountain. Boundaries are drawn to encompass sedimentary basins that are flat or slightly dissected. Many smaller sedimentary basins with the same characteristics are not included, because of their small size and lack of contiguity.	This LTA is characterized as the low, flat-to-rolling lands at the edges or between the igneous knobs, constructed mainly on early Cambrian Bonne Terre chert-free dolomite. Smaller areas of LaMotte and Eminence-Potosi Formations also occur. Soils are mainly deep alfisols, noticeably chert-free for the Ozarks, formed in loess and clayey dolomite residuum with numerous areas of shallow soils on dolomite bedrock. Historic vegetation was a mosaic of oak forest, woodland, dolomite glades, and small prairies. Today this landscape is largely cleared pastureland with timber on steep slopes and along streams. The largest block of public lands is St. Joe State Park, which consists primarily of scarified mine lands. The subsection includes extensive mined areas, especially around Big River in the north and around Mine la Motte and Fredericktown in the south. Urbanization processes are increasingly affecting the LTA, especially along the US 67 corridor.
OZ10c Roselle Oak Woodland Upland Igneous Plain	The LTA occupies a small, compact area northwest of Fredericktown associated with intrusive granitic rock but not in a knob-and-basin topography. Boundaries are drawn to encompass an elevated dissected plain on granite with less than 150 feet of local relief.	The LTA consists of an elevated dissected plain on intrusive igneous rock. Local relief is generally less than 100 feet with occasional low, small knobs. Soils are similar to areas of igneous knobs but have fragipans in higher landscape positions. Historic vegetation was oak woodland with occasional glade openings. Today substantial clearing for pasture has occurred and the woodlands have tended to become second-growth forests.
OZ10d St. Francois Oak-Pine Woodland/Forest Hills	The LTA occurs in two separate tracts. The larger one occupies most of the southern part of the region, and the much smaller one is an isolated set of hills north of Bell Mountain in central Iron County. Boundaries are drawn to encompass hills with 150–300 feet of local relief associated with the Eminence-Potosi Formation.	The LTA consists of moderately to deeply dissected hills associated with the sedimentary Eminence-Potosi Formation. Local relief is 150–350 feet, mainly in broad ridges that give way to steep sideslopes and narrow to broad valleys. Soils are mainly deep, very cherty silt loams, and streams carry heavy loads of chert gravel. Historic and current vegetation is mainly oak-pine woodland and forest with occasional glade openings. Today the forest is younger and more dense, with a much diminished pine component. A minor fraction of the land is in the Mark Twain National Forest.

OZ11
PRAIRIE OZARK BORDER SUBSECTION

(see map pg. 174–175)

GENERAL DESCRIPTION

The subsection is a high, smooth plain mostly of less than 100 feet of local relief. It has a thin layer of loess over Jefferson City–Cotter dolomite in the south and Mississippian limestones on the north. Presettlement vegetation was open bluestem prairie with oak savannas and woodlands in valleys and on steeper slopes. In many respects this subsection is transitional between the wooded hills of the Ozarks and the open Osage Plains to the west. Farms of both cropland and pasture dominate the subsection today, with woodlands on steeper or wetter soils marginal for agriculture.

LOCATION AND BOUNDARIES

The subsection lies in the northwestern Ozarks near the geographic center of the state. It lies mostly in Cooper, Moniteau, and Morgan Counties but also includes small portions of Cole, Miller, Benton, and Pettis Counties. Its southern boundary is very distinct and is drawn where the smooth plain of this subsection abruptly gives way to the dissected hills of the Osage River Hills. This line is also the drainage divide between the Osage and Missouri Rivers. The irregular boundary on the east and north with the Inner Ozark Border and Outer Ozark Border is more transitional and drawn where the local relief increases to more than 150 feet. The western boundary with the Osage Plains Section is very inconspicuous in the landscape and is arbitrarily drawn were relief decreases to less than 150 feet.

CLIMATE

Mean annual precipitation is 40–42 inches. The wettest months are May–June and September, and 63 percent of the annual precipitation occurs during the six warmer months of the year. Annual snowfall averages 18 inches. Mean January minimum daily temperature is 17–18°. Mean July maximum daily temperature is 90°. The growing season averages 210 days. Microclimatic variations are not noteworthy in this subsection because of its relatively low relief.

TOPOGRAPHY AND GEOLOGY

The subsection has a thin layer of loess underlain by a variety of formations that dip so gently northward that they may be considered horizontally bedded. Chief among the formations is the Ordovician Jefferson City–Cotter dolomite. Others are cherty limestones of Mississippian age. Residuum is clayey with rock fragments. The subsection is a gently rolling plain with local relief less than 100 feet, and it approaches flatness in several locations. Relief increases to 150 feet and more along the Lamine River in northern Morgan County. Because of the low relief and thick residuum and soils, bedrock is hardly ever exposed. The plain is highest in the south and slopes northward toward the Missouri River at an average rate of 10 feet per mile.

SOILS

Soils in this subsection are very deep and were formed in cherty dolomite residuum, with a thin veneer of loess on interfluve summits. Most are somewhat poorly drained, with subsoils of silty clay or silty clay loam. In addition, most soils have a moderately thick, dark surface layer, reflecting the native savanna or prairie vegetation. Crestmeade soils are on broad interfluve summits, were formed entirely in loess, and have clayey subsoils. On convex summits, shoulders, and gently sloping sideslopes, the loess is thinner, and soils such as Maplewood and Friendly occur. These soils have very gravelly residuum in the lower part, as well as brittle subsoils that are similar to fragipans but not as restrictive to root penetration. The steeper backslopes have very cherty, red soils such as Eldon.

HYDROLOGY

The subsection lies in the headwaters of the Lamine, Petite Saline, Moniteau, and Moreau drainage systems, all tributary to the Missouri River. As headwater streams, they are mostly intermittent or ephemeral, or perennial with small discharges. Stream channels are silt and gravel bottomed. Higher stream discharges occur during spring and summer in response to high-intensity rains, but flooding is not common on these headwater streams. Springs are present most commonly in the form of hillside seeps during high water table conditions. The subsection lacks natural ponds and lakes, and only stock-watering ponds provide any dependable surface water during summers. Stream water quality is subject to agricultural runoff. Groundwater is abundant.

TERRESTRIAL NATURAL COMMUNITIES

Historic. Tallgrass prairie originally covered over 80 percent of this subsection. It graded into oak savanna on the edges on more sloping areas. Marshy areas of seasonal ponding may have occurred. Only the Springfield Plain would have had a comparable extent of prairie within the Ozark Highlands Section.

Current. Today the region is mainly pasture with substantial cropland, especially in the north on the Mississippian limestone soils. Small, isolated patches of invasive timber occur. Only several small prairie remnants remain. The drainage basin of the Lamine River is much more timbered than the rest of the subsection.

Major Natural Community Types

Midwest Chert Prairie

Central Post Oak Dry Barrens (Savanna)

Rare or Restricted Natural Communities. Chert prairies in the Ozark Highlands are rare and restricted to a few quality remnants in this subsection, the Central Plateau, and the Springfield Plain. Intact post oak barrens are absent. Prairie headwater streams with minimal human impact also occur but are rare.

NATURAL DISTURBANCES

Fire and grazing by native herbivores were natural disturbances in the creation and maintenance of the grassland landscape.

RARE OR ENDANGERED SPECIES

The Prairie Ozark Border contains 64 records of 15 state-listed species. Many of the records are historic prairie chicken leks. Nearly all the species are grassland or prairie stream species. The Topeka shiner *(Notropis topeka)* and Mead's milkweed *(Asclepias meadii)* are the only federally listed species.

NATURAL AREAS

There are no designated Natural Areas in the Prairie Ozark Border.

PUBLIC LANDS

There are only 6,000 acres of public lands in the ecoregion. All are Conservation Areas of the Missouri Department of Conservation: Hite Prairie, Prairie Home, Lamine River, and Manito Lake.

HUMAN GEOGRAPHY

Demographics. Though Indians, chiefly Osages, occupied the subsection, their legacy has probably been more in burning the land than in settlements. Most of the early American settlers (1820s–1840s) were from Kentucky and neighboring states, some with slaves. German immigrants came in the 1850s to 1870s. Mennonites have settled in the south since the 1960s. Rural population reached a peak in 1900 and has been declining ever since, despite the profitability of farming. This rural loss has been largely offset by slow, steady growth of the small towns.

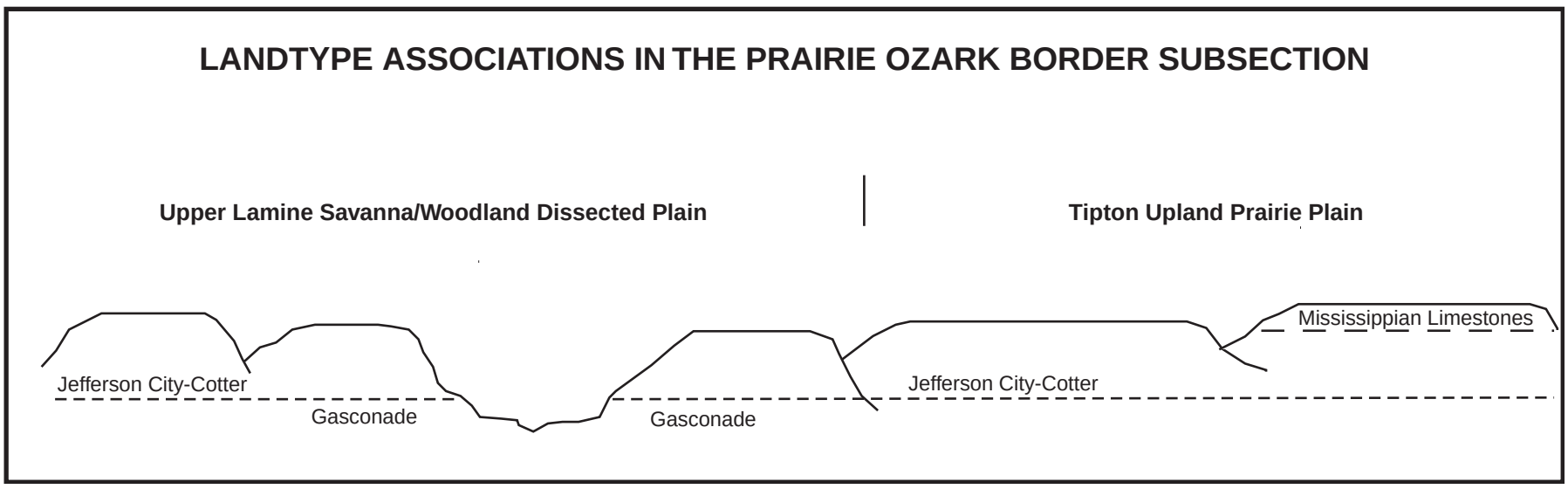
Economics and Land Use. Americans began to farm the more accessible prairie lands of Cooper County around 1820, and farms had fairly well covered the subsection by 1850. Early farms concentrated on stock raising on the prairies, and fields of corn, oats, and wheat. The Civil War greatly disrupted life and prompted an economic readjustment. Railroads made it possible to market grain and animals more efficiently, and agriculture stressed quality in animals and crop products. The vast majority of the land is still in farms, and most of it is in pasture with a strong complement of cropland. Residential and commercial land use is concentrated in the small towns of California, Tipton, Versailles, and Eldon.

LANDTYPE ASSOCIATIONS

The Prairie Ozark Border Subsection is subdivided into two landtype associations (LTAs), distinguished by their local relief and corresponding soil and vegetation patterns. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

Native ecosystems have been reduced to small, isolated fragments in this ecoregion. Only one of the several known prairie remnants is in public ownership. Overall, this is still essentially a grassland landscape that is potentially beneficial to grassland wildlife. While greater opportunities exist to the west, management to enhance grassland quality at a landscape scale may prove beneficial to a variety of grassland species. Careful use of prescribed fire will be essential. Efforts to improve the riparian corridors of streams would also be beneficial.

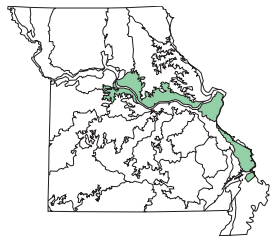


(see landtype associations map pg. 174–175)

LANDTYPE ASSOCIATIONS IN THE PRAIRIE OZARK BORDER SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ11a Tipton Upland Prairie Plain	The LTA occupies most of the subsection, excluding only the rolling headwaters of Lamine River. Boundaries are drawn on all sides to enclose an upland plain with less than 100 feet of local relief.	The LTA consists of a high, slightly dissected plain with less than 100 feet of local relief. It is underlain by Mississippian limestones on the north and Ordovician Jefferson City–Cotter dolomite on the south, but the whole LTA is mantled with loess. A small tract of sinkholes occurs at Prairie Home in the north. Historically it was more than 80 percent prairie, with timber restricted to narrow belts along streams. Today the LTA is mostly pasture with sizeable amounts of scattered cropland.
OZ11b Upper Lamine Savanna/ Woodland Dissected Plain	The LTA occupies the rolling hills in the headwaters of the Lamine River. Boundaries are drawn on all sides to delimit the hills at a change in local relief to less than 100 feet, except the downstream boundary that marks a transition to more than 150 feet and steeper slopes.	The LTA consists of slightly dissected hills with local relief of 100–150 feet cut into Jefferson City–Cotter dolomite. Historically, it was oak savanna and open woodlands. Today, cropland occupies the bottoms and pasture occupies broad ridges and gentle slopes. Blocks of dense second-growth timber occur on steep slopes and in shallow stream valleys on the plain. Several prairie remnants and rare fish species sites occur in the LTA.

OZ12
OUTER OZARK BORDER SUBSECTION

(see map pgs. 174–177)



GENERAL DESCRIPTION

The Outer Ozark Border Subsection consists of a belt of deeply dissected hills and blufflands bordering the Missouri and Mississippi Rivers and several relatively smooth karst plains. Relief in the river hills is mostly 200–350 feet. Slopes are steep and bedrock exposures are common. Loess, occasionally very thick, mantles the uplands of the entire subsection. Geologic strata are variable but consist mainly of Mississippian limestones high in the landscape and a variety of Ordovician dolomite formations in the valleys. The ecoregion was historically timbered in oak savanna and woodland, oak and mixed-hardwood forests, and occasional prairie and glade openings. Today, land use is extremely varied, including row crops, improved pasture, and densely wooded valleys. Urbanization pressures are great in the multicounty St. Louis metropolitan area and at Columbia and Cape Girardeau.

LOCATION AND BOUNDARIES

This extremely irregularly shaped subsection wraps around the Ozarks in a broad arc from central Missouri along the northern side of the Missouri River, through St. Louis, then down the Mississippi River to southeastern Missouri. It is the outermost division of the Ozark Highlands Section on its northern and eastern flanks. Though 220 miles in length, it averages only 20 miles in width and almost pinches out in Jefferson County. It includes portions of nineteen counties and all of the city of St. Louis. At the extreme western end this subsection's boundary is also the boundary between the Ozark Highlands Section and the Osage Plains Section. It is drawn where the greater relief of the Ozarks drops to less than 150 feet in the Osage Plains. At its extreme western end its southern boundary is south of the Missouri River and includes dissected areas on the Mississippian Burlington Formation. From southern Boone County to western St. Charles County the southern boundary is the Missouri River Alluvial Plain, while the northern boundary is based on the higher local relief of the Ozarks. In a general way, this line also separates land without glacial till from land with glacial till to the north, but glacial materials do occur locally on many ridges of the Outer Ozark Border. On the east, the Mississippi River Alluvial Plain is the outer extent, and the boundary with the Inner Ozark Border is the very prominent Burlington Escarpment from Franklin County through Ste. Genevieve County. Local relief of the Outer Ozark Border is significantly greater than that of the Inner Ozark Border along the entire length of this escarpment. In Perry and Cape Girardeau Counties the western boundary is the western limit of an Ordovician limestone karst plain. In northern Scott County, the Benton Hills, a small, disconnected part of the Illinois Ozarks Subsection (222Aq in national system; OZ17 within Missouri), are isolated by the flat alluvial plain of southeastern Missouri. The Benton Hills are included as part of the Outer Ozark Border in this description of Missouri.

CLIMATE

Mean annual precipitation ranges from 40 inches in the north to 46 inches in the southeast. The wettest months are May–June, and 61 percent of the annual precipitation occurs during the six warmer months of the year at Columbia in the north. Comparable figures for Jackson in the south are March–May and November, and 59 percent. Annual snowfall ranges from 20 inches in the north to 12 inches in the southeast. Mean January minimum daily temperature ranges from 17° in the northwest to 22° in the southeast. Mean July maximum daily temperature is 90°. The growing season ranges from 208 days in the north to 215 days in the southeast. Microclimatic variations are significant in areas of greater relief, as in the blufflands along the Missouri and Mississippi Rivers.

Ginseng is one of many species that inhabit the mesic forested ravines in the Outer Ozark Border Subsection.

Jim Rathert

TOPOGRAPHY AND GEOLOGY

The subsection arcs around the northern, northeastern, and eastern flanks of the Ozark structural uplift. Everywhere along its long arc, strata dip outward from the Ozark structural center. In some places the dip is strong, as in Ste. Genevieve County, but more commonly it is relatively gentle and the strata at any one exposure appear to be horizontal. Bedrock is commonly exposed because of the deep entrenchment of streams near the Missouri and Mississippi Rivers. The subsection includes a wide variety of underlying rock types, but the most distinctive is the cherty dolomite of the Mississippian Burlington Formation. It is relatively more resistant than the rocks of other adjacent formations and forms a prominent escarpment that runs from Ste. Genevieve County through Jefferson, northeastern Franklin, southwestern St. Charles, and southern Warren Counties. To the west, the Burlington Escarpment is virtually collinear with the Missouri River bluffs as far as Boone County and then crosses the Missouri River into northern Moniteau and Cooper Counties. The escarpment everywhere makes a bold line of hills that overlook the lower lands on the Jefferson City–Cotter dolomites of the Inner Ozark Border. It is deeply dissected by numerous stream valleys that cut across it. This dissected escarpment is well expressed where the Meramec and Big Rivers cross it, and along the Mississippi River in Jefferson and Ste. Genevieve Counties. Most stream valleys cut completely through the Mississippian formations into Ordovician sandstones and dolomites. Several loess-capped rock benches add variety to the blufflands of Callaway, Montgomery, and Warren Counties.

A completely different physiography occurs in St. Louis County and City and in Ste. Genevieve County where other Mississippian-age limestones produce well-developed karst plains with hundreds of sinkholes, caves, springs, and losing streams. Another large karst plain in Perry and Cape Girardeau Counties is underlain by various Ordovician-age limestones. In all of these karst regions near the Mississippi River the relief is quite low, usually below 150 feet. Eastern Cape Girardeau County is a relatively rugged hill tract of 250–300 feet of local relief, known as the Cape Hills. It is associated with Silurian and Devonian limestones and dolomites. Loess is a major feature throughout all blufflands of the subsection. On some ridgetops it reaches 20 feet of thickness.

The extreme western end of the subsection, which is south of the Missouri River (Moniteau, Cooper, Saline, and Pettis Counties) is also distinguished by the Burlington Formation of cherty limestones and includes steep, entrenched streams and several conspicuous karst tracts. The escarpment crosses to the northern side of the Missouri River near Glasgow and produces a narrowing of the Missouri River valley. The northwestern end of this subsection (Boone and Howard Counties) extends into a region underlain by an alternating series of thin shales, sandstones, limestones, and coals of Pennsylvanian age. The land here is moderately dissected with relief of 150–250 feet. Small karst tracts occur in this area. This area was glaciated, but most of the ice-laid deposits have been removed by postglacial erosion. On some ridgetops of the counties north of the Missouri River, glacial till may be 50 feet thick. It is associated with flattish summits, as at the AmerenUE Callaway Nuclear Plant (Callaway County) and the Columbia Regional Airport (Boone County).

Silica sand is mined from the Ordovician St. Peter sandstone in St. Louis and Jefferson Counties for industrial sand (glass) purposes. Limestone and dolomite quarries are numerous in the blufflands and in the St. Louis metropolitan area. Strip coal mining has scarified lands in Callaway, Boone, and Howard Counties.

A disconnected portion of the Illinois Ozarks Subsection of the national classification system, the Benton Hills of Scott County, is included as part of the Outer Ozark Border (OZ12bb and OZ12cc). It is a bedrock-cored isolated hilly tract (150–250 feet of local relief) that rises abruptly above the alluvial plains surrounding it. It is underlain by the same formation as in the Outer Ozark Border directly north of it with the addition of Cretaceous-Tertiary sandstones and clay, which tie it to the Illinois Ozarks across the Mississippi River. The Benton Hills are capped with deep loess.

SOILS

Soils are diverse within this subsection and vary with parent material and landscape position. Silty loess deposits are very thick adjacent to the Missouri River and thin with distance from it. Soils formed in deep loess deposits include the well-drained Menfro series and the moderately well-drained Winfield series, both with silty clay loam subsoils. Soils farther from the Missouri River formed in thinner loess over dolomite residuum and include the Wrengart series, with a brittle subsoil layer similar to a fragipan but not as restrictive to roots. Steep backslope soils near the loess bluffs were formed in very cherty dolomite residuum and include the very deep, red, very cherty Goss soils and moderately deep, clayey Bardley soils. Farther from the loess bluffs, very deep soils have formed in glacial till on backslopes and include Keswick soils with clay loam subsoils. Several wide alluvial plains with silty soils are included in the subsection, including the Haymond series on low floodplains and the Freeburg series on low terraces.

HYDROLOGY

The subsection is hydrologically extremely diverse. It includes numerous small streams, some intermittent and ephemeral, that drain directly into the Missouri and Mississippi Rivers. The subsection also includes the lowermost portions of the larger tributaries, like Lamine River, Perche and Cedar Creeks, Loutre River, Meramec River, and Apple Creek. Stream valleys are deeply entrenched into the river blufflands of the Missouri and Mississippi Rivers. Gradients of smaller streams are steep. Those streams carry bed loads of gravel and sand, and their channels are usually in gravel, except where close to the Missouri and Mississippi Rivers, where they are silty from backwaters. Streamflow is highest in spring and lowest in fall. Streams are subject to flash floods and may be subject to backflooding during high stages of the Missouri and Mississippi Rivers. Small springs are present, but they are relatively insignificant as a contributor to total stream discharge. Some springs in Cooper, Howard, St. Louis, Jefferson, and Ste. Genevieve Counties are saline. The subsection lacks natural ponds and lakes except for sinkhole ponds, but there are numerous livestock ponds and a constantly growing number of lakes for residential developments, especially in the St. Louis and Columbia urban areas. Stream water quality is subject to degradation from agricultural runoff and may be seriously polluted at times in the St. Louis urban area. Urbanization also aggravates flash flooding. Mining also may affect stream water quality in Jefferson and Ste. Genevieve Counties. Groundwater is abundant and generally of good quality if taken far enough below the static water table. In Cooper and Howard Counties and portions of St. Louis County groundwater is noticeably saline.

TERRESTRIAL NATURAL COMMUNITIES

Historic. Most of the region was historically covered in timber. However, timberlands ranged from oak savannas with widely scattered trees on high, smooth uplands, through open oak woodlands, to dense well-developed forests of oak and mixed-hardwood species in more rugged landscapes. Prairie openings occurred on flatter uplands, and around St. Louis and Perryville. Glades and sinkhole ponds were locally abundant.

Current. The most rugged areas in the subsection are still largely timbered in dense second-growth oak and mixed-hardwood forests. Some of the oldest and most productive forests are found in these areas. Low-relief uplands and broad bottoms have a mixture of fescue pasture and cropland. Bottomland forests are mainly small, isolated fragments. Glades are often overgrown with woody invaders, and prairie openings have been eliminated.

Major Natural Community Types

Central Tallgrass/Post Oak Dry Glaciated Woodland

Central White Oak Dry-Mesic Glaciated Woodland

White Oak–Hickory Dry-Mesic Glaciated Forest

Midwest White Oak–Red Oak Dry-Mesic Glaciated Forest

White Oak–Mixed Oak/Redbud Dry-Mesic Limestone Forest

White Oak–Black Oak Dry-Mesic Chert Woodland

Chinquapin Oak–Ash (Eastern Red Cedar)/Little Bluestem Dry Limestone Woodland

White Oak, Red Oak, Sugar Maple Mesic Limestone Forest

Rare or Restricted Natural Communities. High-quality prairies are absent. Oak savannas and woodlands have converted to forest in the absence of fire or grazing. Glades are also severely overgrown. Large tracts of bottomland forest are rare. Unique sandstone glade and cliff communities are scattered throughout. Fens, seeps, and sinkhole ponds are rare and fragile. Several degraded saline seeps are restricted to the western part of this region. Some of the most outstanding limestone cliffs in Missouri are in this region. Mesic forests with beech and tulip poplar are found only in ravines of southeastern Missouri within this subsection. Caves are locally abundant in several karst plains. Stream communities with unique assemblages occur close to the big rivers.

NATURAL DISTURBANCES

Fire and grazing by native herbivores created and maintained the oak savannas and woodlands of this landscape. Storm damage from wind or ice may have contributed to periodic openings in the canopy of the widespread forests.

RARE OR ENDANGERED SPECIES

This region contains 521 records of 156 state-listed species. This is an exceptionally high number. Federally listed species from the region include decurrent false aster *(Boltonia asteroids* var. *decurrens),* bald eagle *(Heliaeetus leucocephalus),* pink mucket *(Lampsilis abrupta),* gray bat *(Myotis grisescens),* Indiana bat *(Myotis sodalis),* Topeka shiner *(Notropis topeka),* and running buffalo clover *(Trifolium stoloniferum).* Seven state-listed species are found only in this subsection, including the enigmatic cavesnail *(Fontigens antroecetes),* proserpine cavesnail *(Fontigens proserpina),* pink planarian *(Macrocotyla glandulosa),* and a springtail *(Oncopudura hoffi),* all from caves; also a sedge *(Carex laxiflora),* seashore salt grass *(Distichlis spicata),* black rail *(Laterallus jamaicensis),* and hairy skullcap *(Scutellaria elliptica* var. *hirsuta).* An exceptionally high number of listed species are associated with the streams of the region. Additional prominent habitats for rare species in this ecoregion include cliffs (especially sandstone), caves, and bottomland forests.

NATURAL AREAS

The Outer Ozark Border Subsection includes 15 designated Natural Areas. Nine of them represent native forest and woodland communities of the region. These include Babler Southwoods Hollow, Diggs, Engelmann Woods, Kelso Sanctuary, Reifsnider Forest, Schnabel Woods, Vancill Hollow, Weldon Spring Hollow, and Whetstone Creek. Few of these represent fire-prone, open woodlands. Glade/woodland complexes are at Danville Glades and Graham Cave Glades. Geologic features occur at Ball Mill Resurgence, Grand Bluffs, The Pinnacles, and Tower Rock.

PUBLIC LANDS

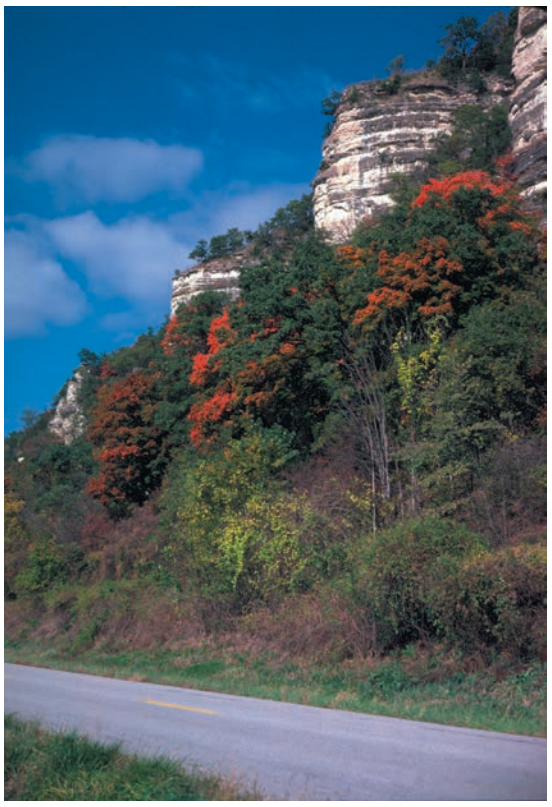
The Outer Ozark Border contains more than 80,000 acres of public lands, the majority of which (58,000 acres) are managed by the Missouri Department of Conservation. Prominent Conservation Areas include Lamine River, Apple Creek, Seventy Six, Magnolia Hollow, Little Lost Creek, Reifsnider, Daniel Boone, Rockwoods, Weldon Spring, Busch, Three Creeks, Danville, Reform, Bennitt, and Whetsone Creek. There are eight state parks with more than 10,000 acres total: Castlewood, Babler, Bothwell, Finger Lakes, Graham Cave, Mastodon, Rock Bridge, and Trail of Tears. More than 12,000 acres of land is in the Cedar Creek and Fredericktown Districts of the USDA Forest Service. Minor acreages are owned by The Nature Conservancy, the U.S. Fish and Wildlife Service, and private conservation lands.

HUMAN GEOGRAPHY

Demographics. A variety of Indian nations occupied different parts of this subsection. Some parts along the Mississippi River were occupied for very long periods of time. In the St. Louis area, Indians of the Cahokia urban complex effectively occupied the land for a few centuries, left large mounds at the site of St. Louis, and may have been partly responsible for the extensive prairies at St. Louis. Great and Little Osages, Missouris, Sacs, and Foxes lived at various times along the Missouri River, and other nations also used the river for transit. Illinois tribes occupied lands along the Mississippi River as settlers and hunters. Shawnees and Delawares had farming villages with a total population of over one thousand on Apple Creek in northern Cape Girardeau County from about 1790 to about 1812. French with slaves established permanent farming villages at Ste. Genevieve (ca. 1750) and St. Louis (1764) and elsewhere in the subsection before 1804. Americans, chiefly from Kentucky, Tennessee, Virginia, and other parts of Appalachia, some with slaves, began settling in the eastern parts of the subsection in the late 1790s and in the Missouri River parts mostly after 1815. Immigrants from Germany began arriving in the 1830s into Warren, St. Charles, St. Louis, and Perry Counties. By the end of the century many parts of these counties were thoroughly "Germanized." Rural farm population, overall, reached a peak at the beginning of the twentieth century and has been declining ever since. The formerly large African American population is almost gone from rural areas. Rural nonfarm populations have grown in the environs of large cities, like St. Louis, Columbia, and Cape Girardeau, where

urbanization has spread into formerly rural areas. Population growth has been very strong in the urbanizing counties of Boone, St. Charles, St. Louis, Jefferson, and Cape Girardeau. St. Louis City and St. Louis County have a combined population of 1.35 million.

Economics and Land Use. The French had large common fields and worked them with their African Caribbean slaves. They also had a livestock economy that used prairies, woodlands, and forests as open range. In most of the subsection the economy of the Anglo-Americans was one of cornfields and cattle and hog raising in the wooded hills. In the western parts (Cooper, Howard, Boone, and Callaway Counties), however, it was a decidedly commercial economy, which added the cash crops of tobacco and hemp to the corn-cattle-hog staple base. The best soils of the region were occupied very quickly, usually by the 1830s. German immigrants introduced wheat as a commercial crop and occupied narrow loess-capped ridges. The subsection contains portions that are mostly pasture and cropland (Cooper, Perry, and Cape Girardeau Counties), mostly forested (Warren, Montgomery, and Ste. Genevieve Counties), some that are apparently reverting from cropland to pasture and woodland (Callaway and Howard Counties), and some that are dominated by urban land uses (St. Louis, Jefferson, and Boone Counties). In general, where not urbanized, steep slopes are forested and wooded, gentler slopes are in pasture, and bottomlands and upland surfaces are in crops or pasture. Urban centers and their complex economies dominate this subsection. The St. Louis metropolitan area, especially, exerts a strong influence on economics and land use for dozens of miles outward. Even in areas far from cities there is widespread commuting into the cities. Agriculture and rural-based economics are small-scale and localized.



Grand Bluffs Natural Area at Bluffton is an outstanding example of the high bluffs lining the rivers of the Outer Ozark Border Subsection.
Missouri Department of Conservation

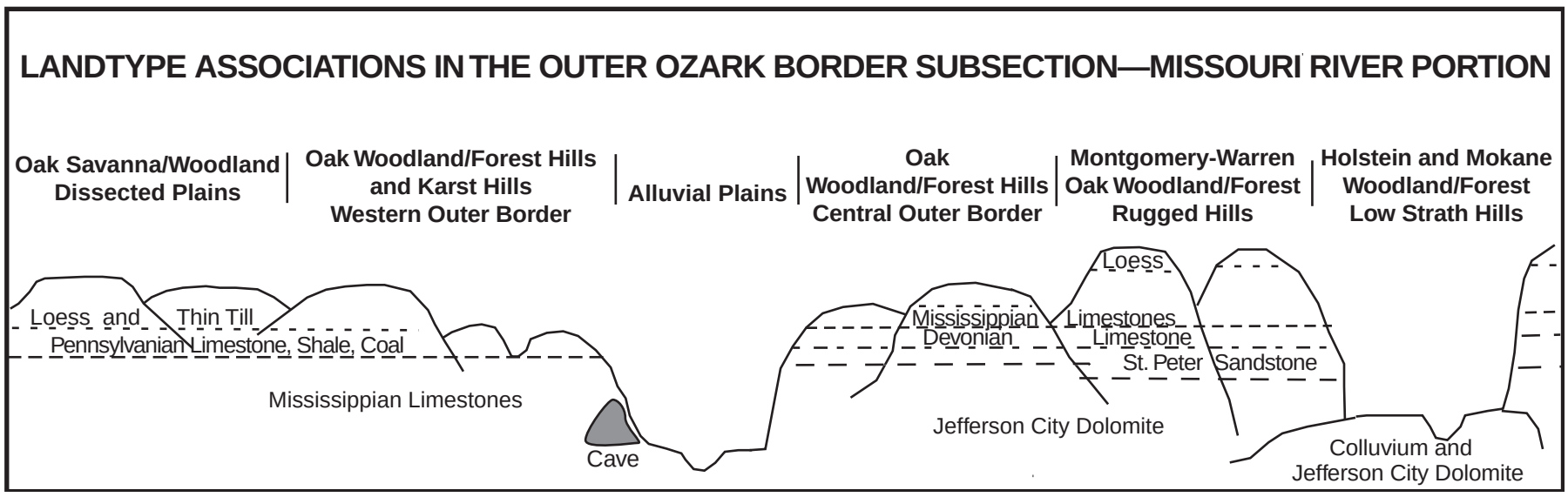
LANDTYPE ASSOCIATIONS

The Outer Ozark Border Subsection is subdivided into twenty-eight landtype associations (LTAs). The LTAs are differentiated based on variation in local relief and geology, and corresponding soil and vegetation patterns. They include rugged, timbered hills along the rivers, rolling woodland/forest hills, and gently rolling to flat dissected plains. Several LTAs are recognized for their concentrated karst features. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

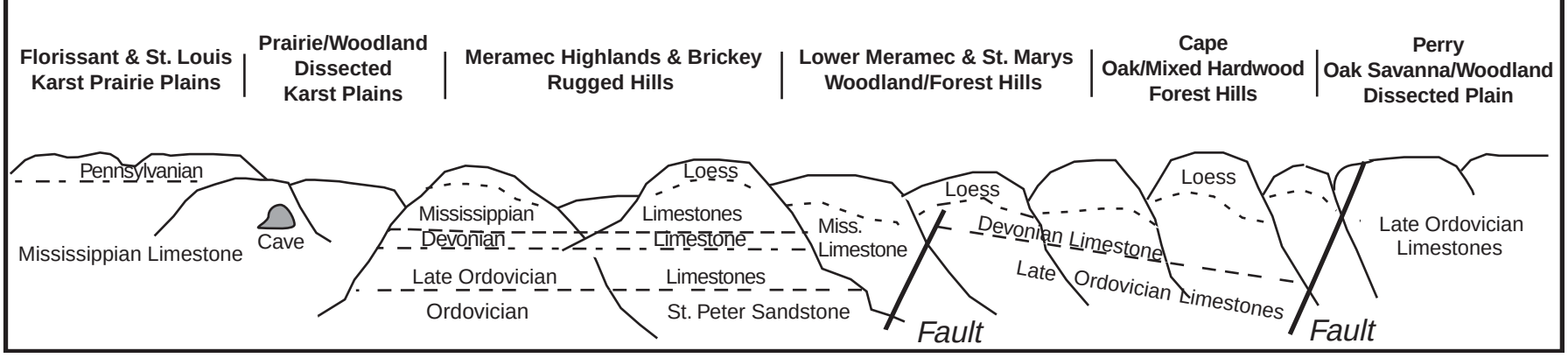
The Outer Ozark Border is occupied by an exceptional number of roads and towns with their potential development impacts. Proximity to the big rivers has fostered human use for a long time. Consequently, the varied native ecosystems of the region are largely fragmented and somewhat degraded. The prairies, savannas, open woodlands, and glades characteristic of the region are largely destroyed by urbanization or overgrown with invasive woody species and have a diminished ground flora diversity. Restoration with prescribed fire shows high potential for success and the possibility of developing a coincident grazing and timber resource. There are still exceptionally large blocks of forest associated with more rugged valleys. These could be focal areas for forest conservation efforts. Numerous caves exist; most are on private lands. Streams of the region have outstanding aquatic assemblages that deserve attention. The landscapes with deep loess soils are highly erodible without appropriate development and farming practices. By including natural resources in the long-term development strategy for the region, many of the qualities that make it special might be sustained and enhanced.

LANDTYPE ASSOCIATIONS IN THE OUTER OZARK BORDER SUBSECTION—MISSOURI RIVER PORTION



(see landtype associations map pgs. 174–177)

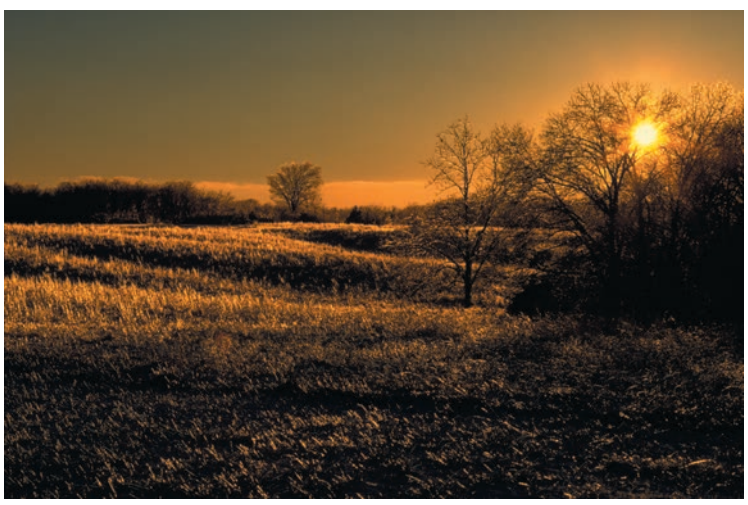
LANDTYPE ASSOCIATIONS IN THE OUTER OZARK BORDER SUBSECTION—MISSISSIPPI RIVER PORTION



LANDTYPE ASSOCIATIONS IN THE OUTER OZARK BORDER SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
(Includes two LTAs that are part of the Illinois Ozarks of the national classification system)		
OZ12a Lower Lamine River Oak Woodland/Forest Hills	The LTA occupies hills associated with Mississippian limestones in the lower Lamine and Blackwater River valleys in the westernmost extension of the Outer Ozark Border. Boundaries are drawn to enclose hills with over 150 feet of local relief and to separate them from surrounding plains.	The LTA consists of broadly rounded uplands that give way to steep slopes that cut from Mississippian through Devonian limestone into Ordovician Jefferson City–Cotter dolomite. Soils are mainly deep, cherty silt loams with occasional areas of shallow soils on bedrock, especially on steeper slopes. Historically, vegetation was oak savanna, woodland, and forest with scattered glades and prairie openings. Some wet prairie and marsh were in the bottomlands. Today, cropland occupies the bottoms and fescue pasture most of the uplands. Second-growth oak timber occurs in steeper valley sides or as trees scattered in pastures. Federally listed Topeka shiners and other rare fish are known throughout the subsection. The LTA contains a couple of remnant saline springs and limestone glades. There is little public land.
OZ12b Arrow Rock Prairie/Woodland Dissected Karst Plain	The LTA occupies a small karst plain around Arrow Rock on the western side of the Missouri River. Boundaries are drawn to encompass the plain with less than 100 feet of relief on soluble Mississippian limestone. The southern boundary is the alluvial plain of the Lamine and Blackwater Rivers. The western and northern boundaries mark the end of karst. The LTA includes an outlier between the Lamine and Blackwater Rivers.	The LTA consists of a very slightly dissected karst plain with relief less than 100 feet. Karst features are prominent, including sinkholes and springs. Soils are deep loams on loess and limestone. A large prairie historically occupied the plain west and south of Arrow Rock, while oak savanna and woodland covered the rest. Today the region is mainly pasture with cropland on flatter uplands and timber scattered in stream valleys.
OZ12c Petite Saline Oak Savanna/ Woodland Dissected Plain	The LTA occupies a dissected plain drained by the Petite Saline Creek south of Boonville on the Missouri River, completely in Cooper County. Boundaries mark a change to local relief of more than 150 feet on the western and eastern sides. The northern boundary is with the Missouri River alluvial plain. The southern boundary is placed where local relief declines to less than 100 feet.	The LTA is a gently rolling upland drained mostly by Petite Saline Creek, which has an unusually wide valley. Local relief varies from less than 50 to more than 150 feet in the Missouri River blufflands. Loess mantles the whole LTA. Lithology is variable, with Pennsylvanian sandstone and shale around Boonville and Mississippian limestones elsewhere. Historically oak savanna and woodland with numerous prairie openings, today the LTA is mainly pasture with cropland in the bottoms and flatter uplands and second-growth timber on steeper slopes. I-70 cuts across the LTA and creates development activities.
OZ12d Jamestown Oak Woodland/ Forest Karst Hills	The LTA occupies steep-sided hills on the southern side of the Missouri River between Petite Saline and Moniteau Creeks. Boundaries encompass steep loess-covered hills with 200–250 feet of local relief. The northern boundary marks a conspicuous descent in elevation of almost 100 feet to the Petite Saline Dissected Plain.	The LTA consists of a belt of steep-sided, loess-covered hills, narrow ridges and narrow valleys that is the most rugged bluffland on the southern side of the Missouri west of the Osage River. The LTA is underlain by carbonate strata everywhere. Historically it was oak savanna and woodlands high in the landscape, and dense oak and mixed-hardwood forests in the steep-sided limestone ravines. Today the narrow uplands are mainly fescue pasture, while the steep ravines are largely timbered in second-growth forest and old-field cedar thickets. Caves are common, and springs drain off water from the Prairie Home karst plain to the west.
OZ12e Boonslick Oak Woodland/ Forest Hills	The LTA occupies moderately dissected hills on the northern side of the Missouri River in Howard County. The northwestern boundary marks the farthest upstream extent of the Ozark Highland Section and is arbitrarily drawn on a minor drainage divide to separate an Ozark landscape influenced by carbonate lithology and loess from one influenced by glacial materials. The eastern boundary (drawn arbitrarily on a minor drainage divide) marks the limit of saline ground and surface waters. The short southeastern boundary marks a change to lesser local relief and also absence of salinity. Elsewhere the boundary is the Missouri River alluvial plain.	The LTA is a transitional landscape between the Ozarks and the Dissected Till Plain. It consists of broadly rolling hills with a local relief of 150 feet that increases to 200 feet closer to the Missouri River. The uplands have a covering of loess (deep loess in the immediate blufflands) over till in the west and north and directly over Pennsylvanian and Mississippian sedimentaries elsewhere. In places the surface is intricately dissected into deep ravines. Springs are saline, including ones at Boone's Lick State Park and at Moniteau Lick, and streams tend to be saline. Historically, the LTA was timbered in oak woodland and forest in the deep valleys, a condition that may be a fire shadow effect of the Missouri River. Today, the landscape is over 75 percent pasture with cropland (including tobacco) on gentler slopes, and second-growth forest and dense cedar-hardwood old-field thickets in small isolated patches.

(table continued on pg. 138)

LANDTYPE ASSOCIATIONS IN THE OUTER OZARK BORDER SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ12f Harrisburg Oak Woodland/ Forest Hills	The LTA occupies the hills of the upper Perche Creek basin in northwestern Boone County. The western boundary is drawn (for convenience along a minor drainage divide) where saline groundwater occurs. The southern boundary marks a decrease in local relief and the beginning of karst influence. Other boundaries are with the very low-relief till plains.	Like the Boonslick Hills, this LTA is transitional between the Ozarks and the Dissected Till Plains. The hills are moderately dissected with local relief of 150–200 feet. The bedrock base is mainly Pennsylvanian sandstone and shale with Mississippian limestone in lower reaches of valleys. Glacial till occurs on uplands covered thinly with loess. Thinner Pennsylvanian strata and a greater influence of Mississippian carbonate rocks may account for lesser saline influence here. Historically, the LTA was timbered in oak woodland and forest, but there is no evidence of prairies as in Boonslick Hills. Today, the upland surface is mainly pasture with a very small amount of cropland. Second-growth forest and old fields of dense cedar-hardwood occupy the roughest lands. The LTA contains numerous records for the federally listed Topeka shiner.
OZ12g Rock Bridge Oak Woodland/ Forest Low Karst Hills	The LTA occupies hills with karst features associated with Hinkson Creek. Broad, gently rolling uplands and deep, abruptly dissected valleys associated with Hinkson, lower Perche, and other creeks in Boone County and Columbia. It is separated from all surrounding LTAs on the basis of well-developed karst.	The LTA consists of loess-covered upland divides dissected by deeply entrenched streams cutting through Mississippian limestones. Till is almost completely absent. The landscape is replete with sinkholes, losing streams, and numerous caves. Local relief averages 200 feet but is noticeably lower in the lower Perche valley. The LTA includes the Manitou Bluffs between Rocheport and McBaine. Historically, the LTA was oak savanna and woodland on the upland surface, while oak and mixed-hardwood forests covered the valley slopes and bottoms. Some poorly drained, ephemeral wetlands and some prairies may have occupied the flatter uplands. Today, the landscape is dominated by Columbia and its rapidly expanding urban influence. However, many of the valleys are still timbered and relatively wild. Many of the caves and their rare species are protected in parks and conservation areas.
OZ12h Central Missouri Oak Woodland/Forest Hills	The LTA occupies the river hills from southern Boone County to eastern Callaway County. The northern boundary marks the limit of steep-sided hills with relief of over 150 feet. The southern boundary is the Missouri River alluvial plain. The upstream boundary marks the beginning of strong karst in the landscape. The downstream boundary marks the beginning of higher-relief hills associated with St. Peter sandstone.	The LTA consists of deeply dissected hills and bluffs with local relief ranging from 150 feet away from the Missouri River to more than 250 feet close to it. Bluffs along the Missouri River and entrenched tributaries have bold rock cliffs. Loess is thick near the bluffs and thins away from them. Narrow loess-covered ridges give way to steep slopes and narrow valleys in Mississippian and Devonian limestone, and Ordovician Jefferson City–Cotter dolomite. Cedar and Auxvasse Creeks form the largest valleys. Soils range from deep silt loams in loess, through cherty silt loams from limestone, to shallow soils over bedrock. Historically, oak woodland graded into oak and mixed-hardwood forests in the valleys. Frequent limestone and dolomite glades and woodlands occurred on exposed slopes. Today, some of the ridges and bottoms are cleared pasture with limited cropland or dense cedar-hardwood old-field thickets. Steeper lands are largely timbered in second-growth forest with numerous overgrown limestone or dolomite glades. Streams contain federally listed Topeka shiners and other rare fish species. Some outstanding glades occur. Several unique areas are associated with isolated outcrops of St. Peter sandstone. Public lands include some national forest land and state conservation land.



Cliff White

Fingers of glaciated uplands extend south into the Outer Ozark Border Subsection near Columbia, Missouri.

LANDTYPE ASSOCIATIONS IN THE OUTER OZARK BORDER SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ12i Montgomery-Warren Oak Woodland/Forest Rugged Hills	The LTA occupies a 60-mile-long belt of rugged hills and blufflands on the northern side of the Missouri River between eastern Callaway County and the US 40 bridge in St. Charles County. The northern boundary is drawn where relief decreases to less than 150 feet; generally this is the boundary with the glaciated plains. The southern boundary is generally the Missouri River alluvial plain. The western boundary is placed where relief is slightly lower and St. Peter sandstone is of less influence.	The LTA consists of narrow, loess-covered ridges that give way to steep slopes and deep, narrow valleys. Local relief ranges from 150 feet close to the northern boundary to more than 250 feet close to the Missouri River, where high cliffs are common. Most uplands are underlain by Mississippian and Devonian limestone, while the valleys are in Ordovician St. Peter sandstone and Jefferson City–Cotter dolomite. The sandstone often forms prominent cliffs, waterfalls, and box canyons. The Loutre River, the largest stream, and numerous small, high-gradient streams flow in deeply entrenched valleys. Soils include deep silt loams in loess in the blufflands, cherty silt loams from limestone, and shallow soils directly on bedrock. Many unique plant species are associated with sandstone cliffs. Historically, oak woodland on uplands graded into oak and mixed-hardwood forests in the valleys. Frequent limestone and sandstone glades and woodlands occurred on exposed slopes. Today, many of the ridges and bottoms are cleared pasture with limited cropland in the Loutre valley or dense cedar-hardwood, old-field thickets. Steeper lands are still largely timbered in second-growth forest with frequent overgrown limestone or sandstone glades. Some of the largest blocks of contiguous forest in mid-Missouri occur here. Several state conservation areas are in the LTA. Numerous rare and unique species are associated with sandstone canyons. Some outstanding glades occur.
OZ12j Mokane Mixed-Hardwood Woodland/Forest Low Strath Hills	The LTA occupies a small, narrow area associated with a rock-underlain bench or strath bordering the Missouri River alluvial plain near Mokane in south-central Callaway County. The northern boundary marks a conspicuous rise to the prevailing upland surface. The southern boundary is the Missouri River alluvial plain.	The small LTA consists of a narrow belt of low, loess-covered hills that create a strath in the bluffs along the Missouri River. The tops of ridges lie 100 feet above the Missouri River alluvial plain but 100–200 feet below the prevailing upland surface of the surrounding LTA. Deep loess deposits cover Jefferson City–Cotter dolomite. Soils are loess-derived. Historically the strath was oak and mixed-hardwood woodland and forest. Today timber has been largely cleared and the landscape is nearly all pasture with scattered cropland and old-field thickets; timber is restricted to steeper slopes.
OZ12k Holstein Mixed-Hardwood Woodland/Forest Low Strath Hills	The LTA occupies a small, narrow area associated with a rock-underlain bench or strath bordering the Missouri River alluvial plain near Holstein and Marthasville in southeastern Warren County. The northern boundary marks a conspicuous rise to the prevailing upland surface, the Burlington Escarpment. The southern boundary is the alluvial plain.	The small LTA occupies a narrow belt of low, loess-covered hills. The tops of ridges lie 100 feet above the Missouri River alluvial plain but 100–200 feet below the prevailing upland plain of the surrounding LTA. Deep loess deposits cover Jefferson City–Cotter dolomite. Soils are loess-derived. Historically, the LTA was oak and mixed-hardwood woodland and forest. Today, the landscape is a mixture of pasture, some cropland, and second-growth forest on the steeper slopes. Wegner Woods is a small old-growth forest remnant that permits a view of the outstanding productivity of this landscape.
OZ12l Loutre River Alluvial Plain	The LTA occupies the lower 20 miles of the Loutre River and its alluvial plain in Montgomery County.	The small LTA consists of the flat alluvial plain of the lower Loutre River where it is at least 1 mile wide. Several high alluvial terraces, well above any possible floods, lie in the lower part of the valley. Deep, loamy, alluvial soils historically supported bottomland forest. Today the alluvial plain is almost all cropland and pasture.
OZ12m Central Missouri Oak Savanna/Woodland Dissected Plain	The LTA occupies a flat to rolling dissected plain at the northern edge of the Outer Ozark Border mostly in Callaway County between upper Cedar Creek on the west and the upper Loutre River on the east. The northern boundary marks a decrease to land with less than 100–150 feet of local relief and the beginning of the flat till plain. The southern boundary excludes higher relief hills closer to the Missouri River with over 150 feet of local relief.	The LTA is a transition between the Ozarks and the till plain. Many of the uplands are flat and have glacial till, which appear as fingerlike extensions of the till plain projecting toward the Missouri River. The valleys are reasonably deep and represent Ozark-like landscapes projecting northward from the Missouri River. Local relief averages 150–200 feet. Soils vary from claypans and silty clays on the loess-covered divides to cherty loams in the valleys. Historically, the LTA was oak savanna and woodland in the valleys and mostly prairies on the flat ridges. Today, the LTA is mainly fescue pasture with scattered cropland and dense old-field thickets and second-growth timber on steeper slopes. Development pressures are occurring at Fulton and along the major highways. Missouri's only commercial nuclear power plant is on a flat upland in southeastern Callaway County.

(table continued on pg. 140)

LANDTYPE ASSOCIATIONS IN THE OUTER OZARK BORDER SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ12n Wildwood Loess Woodland/ Forest Breaks	The LTA is located in the dissected hills on the southern side of the Missouri River in eastern Franklin County and western St. Louis County. The northern boundary is the Missouri River alluvial plain. The southern boundary marks a decrease to less than 150 feet of relief or a reduction in the influence of loess. The western boundary is the Burlington Escarpment.	The LTA consists of a belt of strongly dissected hills with local relief between 150 and 250 feet. Narrow ridges and steep sideslopes are cut into deep loess over a variety of geologic strata including Mississippian limestones and Ordovician St. Peter sandstone. Historically, the LTA was timbered in oak and mixed-hardwood forest. Today, it is still largely forested with dispersed and concentrated residential and commercial developments increasing. Babler State Park lies in these rugged hills.
OZ12o Chesterfield Oak Savanna/ Woodland Dissected Plain	The LTA occupies a high, flat to gently rolling divide between the Meramec basin and the small drainage basins tributary to the Missouri River. Parts of MO 100 and US 40 follow the ridges. Boundaries are drawn to enclose a dissected upland plain with less than 150 feet of local relief.	The LTA consists of a slightly dissected upland with a thin mantle of loess and relief mainly less than 100 feet. The LTA was historically oak savanna and woodland. Today it is dominated by residential and commercial development of suburban St. Louis with little fescue pasture and cropland left.
OZ12p St. Louis County Prairie/ Savanna Dissected Karst Plain	The LTA lies in the most completely urbanized portion of St. Louis County and lies between the Missouri and Mississippi Rivers, roughly within the I-270 arc. Boundaries are drawn to encompass a dissected plain with less than 100 feet of local relief but excluding flat plains at St. Louis City and Florissant. The Missouri and Mississippi River alluvial plains make up northern and eastern boundaries. The southwestern boundary is placed where relief increases above 100 feet.	The LTA consists of an elevated, very slightly dissected plain with local relief less than 100 feet. Streams flow in shallow valleys but many have been diverted underground by urbanization. Loess formerly covered the LTA but has been largely removed during a century of urbanization. Underlying strata are mostly Mississippian limestones with some Pennsylvanian sandstones and shales in northern parts. Sinkholes and other surface karst features are common but partially obliterated by urbanization. Historically the LTA was extensive prairie on the flattest lands, grading into oak savanna and woodland. Today this landscape is heavily urbanized.
OZ12q Florissant Karst Prairie Plain	The LTA occupies a flat plain in north St. Louis County in the Coldwater Creek basin at Lambert–St. Louis International Airport and Florissant. Boundaries are drawn to encompass a flat area with less than 50 feet of local relief.	The LTA consists of an flat upland plain (the site of glacial Lake Florissant) with less than 50 feet of local relief but somewhat greater at the northern end near the Missouri River. Most streams have been diverted underground. Deep sinkholes and other karst features are common, especially in the north. Historically the LTA was mostly a large marsh and pure prairie, with timber in the sinkholes and bluffs at the northern end. Today the area is strongly urbanized with extensive commercial, industrial, and residential development, including Lambert–St. Louis International Airport.
OZ12r St. Louis Karst Prairie Plain	The LTA occupies a flat plain, slightly elevated above the Mississippi River, associated with most of the city of St. Louis. The eastern boundary is the Mississippi River alluvial plain. Other boundaries are drawn to enclose a flat area with less than 75 feet of local relief.	The LTA consists of a flat plain mostly with less than 50 feet of local relief. Karst features were common, including caves, hundreds of sinkholes, solution basins, natural bridges, and losing streams, but urbanization has obliterated most of these. Historically the LTA was nearly pure prairie with scattered timber and brush in sinkholes. Today the area is completely urbanized with industrial, commercial, and residential development.
OZ12s Lower Meramec Hills Alluvial Plain	The LTA occupies the lower 15 miles of the Meramec River alluvial plain from Peerless Park (MO 141) to its mouth. The upstream boundary is at the higher-relief Meramec Highlands LTA.	The LTA consists of the flat alluvial plain of the Meramec River where it flows through hills with moderate relief and is wider and less sinuous than the reach above. The channel carries heavy loads of gravel and has gravel bars and gravelly alluvium, but it is siltier near the mouth where it is affected by backwaters and ponding from the Mississippi River. Historically it was in bottomland forest; today it is mainly urbanized in industrial parks and commercial land use, with remnant tracts of cropland and riverfront timber. Numerous records of rare mussel and fish species occur.
OZ12t Lower Meramec Oak and Mixed-Hardwood Woodland/ Forest Hills	The LTA occupies hills flanking the Meramec River in its lower 15 miles. Boundaries are drawn at a local relief of 150 feet on the north and 250 feet on the south, separating the LTA from lower-relief plains to the north and significantly higher-relief hills to the south and west.	The LTA is transitional between the flat karst plain to the north and the rugged timbered hills to the south and west. Local relief averages 100–150 feet, greater on the southern side of the Meramec River. Broad, loess-covered ridges give way to steep slopes and broad valleys cut into soluble Mississippian limestones. Historically, the LTA was oak and mixed-hardwood forest. Today, this landscape has widespread residential development and commercial development along highways, but a third of the area remains in pasture or second-growth forest awaiting urbanization.

LANDTYPE ASSOCIATIONS IN THE OUTER OZARK BORDER SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ12u Lower Meramec Highlands Alluvial Plain	The LTA occupies the Meramec River alluvial plain for 25 miles through the rugged Meramec Highlands LTA between Peerless Park (MO 141) and Pacific. The upstream boundary is at the Burlington Escarpment and the lower-relief Outer Ozark Border Subsection.	The LTA is a flat alluvial plain entrenched in rugged hills. This reach of the Meramec River has a narrower, more sinuous valley and is a higher-gradient stream than the stretch below. It carries heavy loads of gravel. Historically it was in bottomland forest. Today it is mainly cropland and tracts of forest, but with much less industrial and commercial development than downstream. This stretch has long been used for recreation by residents of the St. Louis region. Numerous records of rare mussel and fish species occur.
OZ12v Meramec Highlands Oak Woodland/Forest Rugged Hills	The LTA occupies a well-defined belt of rugged hills that extends from the drainage divide between Missouri and Meramec Rivers in eastern Franklin County across the Meramec River to the Mississippi River in northern Jefferson County. The boundaries on both the northeastern and southwestern flanks are placed where relief declines to less than 250 feet. The southwestern boundary is the prominent Burlington Escarpment. The boundary on the northwestern tip is placed where loess significantly mantles the hills along the Missouri River.	The LTA consists of very rugged hills with narrow ridges with isolated knobs, steep slopes, and narrow valleys carved into late Ordovician sandstones and dolomites. The highest ridges on the southwestern side are capped by the Mississippian limestones of the Burlington Escarpment. Local relief is above 250 feet, rising to 350 feet along the Mississippi River and the southwest-facing Burlington Escarpment. Historically, the LTA was timbered in oak and mixed-hardwood woodland and forest with scattered glades. Today this region is significantly less urbanized than adjacent lands of lower relief, but development is rapidly encroaching along highways, especially I-44 and I-55. Much of this landscape is still timbered in second-growth forest. Unique sandstone communities occur. Several large conservation lands include Rockwoods, Young, and Pacific Palisades Conservation Areas, and Castlewoods and Mastodon State Parks.
OZ12w St. Mary Oak and Mixed-Hardwood Forest Hills	The LTA occupies a long, narrow belt of hills and short, steep drainages along the Mississippi River from just north of Ste. Genevieve south to Brazeau Creek in southeastern Perry County. The northwestern boundary with the Brickey Hills is drawn where lithology changes and relief increases sharply to more than 150 feet. The southwestern boundary with the Perry Oak Savanna/Woodland Dissected Plain LTA is drawn where relief decreases to less than 150 feet. The other boundaries are the low bluffs along the Mississippi River.	The LTA consists of a narrow belt of loess-covered river hills dissected by numerous short, steep-gradient tributaries to the Mississippi River. Local relief averages 150–200 feet but rises to more than 300 feet in the extreme southeast. Bedrock and residual soils are exposed in some steep valleys. Rock types are quite variable but are mainly highly soluble Mississippian and late Ordovician limestones. Karst features, including sinkholes and springs, are common near Ste. Genevieve and in Perry County. Bedrock is exposed in steep-sided valleys. Upland soils are developed in loess but are cherty residual soils on steep slopes. Historically, the LTA was timbered in oak and mixed-hardwood forests, including some with beech, magnolia, and tulip poplar, and prairies in the karst upland at Ste. Genevieve. Today, in the northern half near Ste. Genevieve, most land is in pasture; the bottoms and flat uplands are croplands. The southern parts of the LTA have timbered ravines along with pasture and cropland on loess uplands.
OZ12x Brickey Limestone Glade/ Mixed-Hardwood Forest Rugged Hills	The LTA occupies a prominent ridge of rugged limestone hills along the Mississippi River from Festus in central Jefferson County to central Ste. Genevieve County. Boundaries are drawn to enclose a distinct line of hills that rise up sharply from surrounding lands.	The LTA consists of a long, narrow belt of prominent, rugged hills along the Mississippi River and slightly away from it. The hills rise sharply from the adjacent upland and alluvial plains with local relief reaching over 300 feet. The bluffs along the Mississippi River are among the highest in Missouri. The line of hills is deeply cross-trenched by high-gradient streams transverse to it; the valleys so produced are canyonlike. Loess-capped ridges give way to steep limestone slopes. Lithology is complex but mainly Mississippian and late Ordovician limestones. The LTA was historically and is still timbered in oak and mixed-hardwood forests. Some deep ravines and valleys are exceptionally mesic with eastern mesophytic species like magnolia. Overgrown limestone glades and woodlands are common on exposed southwest-facing slopes, and seeps line many stream valleys.
OZ12y Zell Platform Woodland/ Forest Low Hills	The LTA occupies an unusually long, narrow, flat lowland between the Brickey and Kinsey Hills that I-55 takes advantage of in southern Jefferson County and most of Ste. Genevieve County. Boundaries encompass an area of low relief (less than 150 feet) sandwiched between the two higher-relief hill landscapes.	The LTA consists of a long, narrow, valley that occupies a strike valley between two eastward-dipping cuestas. Relief on the lowland is 100–150 feet but is slightly higher in the northern end and where streams have dissected it. It is underlain mainly by weak Ordovician St. Peter sandstone. Historically it was oak woodland and forest. Today it is mainly fescue pasture with occasional cropland. It also serves as the I-55 corridor.

(table continued on pg. 142)

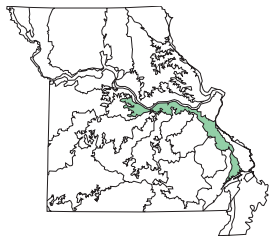
LANDTYPE ASSOCIATIONS IN THE OUTER OZARK BORDER SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ12z Cape Oak–Mixed Hardwood Forest Hills	The LTA occupies a compact area of hills along the Mississippi River mostly in Cape Girardeau County. Boundaries sharply separate the hills with 150–300 feet of local relief from an upland plain to the west and the Mississippi River alluvial plain to the east.	The LTA consists of moderately rolling to intricately dissected and steep-sided hills bordering the Mississippi River. Local relief is generally 200–300 feet. The tract is deeply cut through by high-gradient streams. The ridges have a deep cover of loess over Silurian and Devonian limestones. Historically the LTA was covered in oak and mixed-hardwood woodland and forest. Today the flatter uplands and bottoms are in fescue pasture or small areas of cropland, while the steep ravines are still densely forested. Unique mesophytic forests with beech and tulip poplar as principal components are well developed here. Trail of Tears State Park and Apple Creek Conservation Area have good examples of forests. Urbanization around Cape Girardeau is encroaching into the southern parts of the LTA.
OZ12aa Perry Oak Savanna/ Woodland Dissected Plain	The LTA occupies a broad, flat to gently rolling plain bisected by I-55 for 50 miles from northern Perry County to the end of the Ozarks in southern Cape Girardeau County. Boundaries encompass dissected plains with less than 150 feet of local relief and separate them from adjacent hills and an alluvial plain on its southern end.	The large LTA consists of a long, broad, flat to gently rolling dissected plain associated with several soluble, early Ordovician limestone and dolomite formations. Loess mantles the plain. Local relief is less than 150 feet and commonly less than 100 feet. Karst features are widespread throughout the plain. Sinkholes, caves, and losing streams are most concentrated in central Perry County. Much of this landscape was described originally as “barrens” or tallgrass prairie with widely scattered trees; timber was along the larger streams such as Apple Creek. Today the region is mainly fescue pasture with significant amounts of cropland. The LTA experiences development influences associated with I-55, Jackson, and Cape Girardeau.
OZ12bb Benton Loess Woodland/ Forest Hills *(Included in Illinois Ozarks in National Subsections)*	The LTA occupies a small, isolated tract of hills surrounded by the Mississippi River Alluvial Plain in northern Scott County. Boundaries are drawn at the base of the hills, excluding narrow areas of alluvium and colluvium associated with the hills.	The LTA consists of an isolated set of hills that are topographically and geologically connected to the Illinois Ozarks across the river but geographically associated with the Missouri Ozarks. Tertiary and Cretaceous sandstones, siltstones, and shales, uncommon in Missouri, form the substrates but are covered deeply by loess. Ordovician bedrock occurs lower on the hillsides. Local relief is generally 150–250 feet. Upland soils have formed in the deep loess. Historically the hills were covered in oak woodland on the uplands, with oak and mixed-hardwood forests in more dissected areas. Eastern mesophytic species, including beech and tulip poplar, were present. Today most of the timber has been cleared for pasture and cropland; only the steepest ravines are forested.
OZ12cc Benton Hills Alluvial Plains and Footslopes *(Included in Illinois Ozarks in National Subsections)*	The LTA occupies narrow alluvial plains and colluvial footslopes associated with the isolated set of Benton Hills in northern Scott County. Boundaries encompass the alluvial bottomlands within the hills and alluvial deposits at the edge of the hills whose source materials are related to them.	The LTA consists of narrow alluvial plains and colluvial footslopes and terraces in and at the edge of the Benton Hills. The alluvium and colluvium are the products of redeposition of loess eroded from the Benton Hills. Soils are deep with silty surfaces over poorly drained subsoils. Historically the LTA was bottomland forest and swamps; today it is almost completely cleared for cropland.

Ringed salamanders enjoy the cool, moist, forested ravines of the Outer Ozark Border Subsection.

Jim Rathert

OZ13
INNER OZARK BORDER SUBSECTION

(see map pgs. 174–177)



GENERAL DESCRIPTION

The subsection consists of dissected plains and hills with various expressions of local relief with a range of 150–300 feet. While much of the region is moderately rolling, steeper, more rugged areas occur near some of the major streams. The subsection is defined largely by its association with the dolomites of the Jefferson City–Cotter Formation and loess-mantled ridges. Presettlement vegetation was largely oak savanna, woodland, and forest with frequent glades and small prairie openings. Land use is extremely varied, from row crops and improved pasture to overgrown glades and dense second-growth oak forests. Urbanization pressures are strong at Jefferson City and in Franklin and Jefferson Counties.

LOCATION AND BOUNDARIES

This extremely irregularly shaped subsection wraps around the interior Ozarks from central Missouri to southeastern Missouri. Though 230 miles in length as an arc around the northern and eastern Ozarks, it is nowhere more than 20 miles wide and is more commonly only 10 miles wide. It is composed of portions of seventeen counties. Boundaries are complex and vary in definition. They are drawn principally to encompass areas associated with the Jefferson City–Cotter Formation and loess-covered ridges and uplands. In the north the outer boundary is along the Missouri River bluffs. In the northeast the boundary with the Outer Ozark Border is drawn at the foot of the Burlington Escarpment beyond which local relief rises quite sharply above 250 feet in the Outer Ozark Border. In the southeast, in Perry and Cape Girardeau Counties, the outer boundary is drawn where the dissected hills of the Inner Ozark Border changes to a limestone plain with karst features of the Outer Ozark Border. The inner boundary in the north is drawn where the loess-mantled surface of the Inner Ozark Border gives way to residual soils typical of the interior Ozarks. In the extreme west, the boundary with the Prairie Ozark Border is drawn where local relief declines to less than 150 feet, and the boundary with the Outer Ozark Border is drawn where Mississippian cherty dolomites (Burlington Formation) begin to dominate the landscape. In Jefferson and eastern Franklin Counties the inner boundary with the more rugged Meramec River Hills region is also one where local relief increases to greater than 150 feet, but it is difficult to find in the landscape because it is so gradual a change. The boundary with the St. Francois Knobs and Basins Subsection is drawn to exclude low-relief sedimentary basins and igneous outcrops from the Inner Ozark Border Subsection, but to include the dissected Cambrian sandstone topography along the St. Francois–Ste. Genevieve county line. The inner boundary in Bollinger County lies in a transition zone and it uses the boundary between soils derived from sandstone (Black River Ozark Border Subsection) and those derived from limestone (Inner Ozark Border Subsection).

CLIMATE

Mean annual precipitation is 40–42 inches. The wettest months are May–June, and 64 percent of the annual precipitation occurs during the six warmer months of the year (at Union). Annual snowfall ranges from 18 inches in the north to 12 inches in the southeast. Mean January minimum daily temperature ranges from 17° in the northwest to 22° in the southeast. Mean July maximum daily temperature is 90°. The growing season ranges from 210 days in the north to 215 days in the southeast. Microclimatic variations are significant in areas of greater relief.

TOPOGRAPHY AND GEOLOGY

The subsection lies on the northern, northeastern, and eastern flanks of the Ozark uplift. Everywhere along its long arc around the uplift, strata dip outward from the Ozark structural center. In some places the dip is strong, as in Ste. Genevieve County, but more commonly it is relatively gentle and the strata at any one exposure appear to be horizontal. Bedrock is frequently exposed because of the deep entrenchment of streams near the Missouri and Mississippi Rivers. One of the most intensely faulted (though inactive) regions of Missouri lies in this subsection in southern Ste. Genevieve County, where rocks of contrasting lithologies and differing ages are juxtaposed. The subsection includes a wide variety of underlying rock types, but it is dominated by the cherty dolomites of the Ordovician Jefferson City–Cotter Formation, and their dominance helps to distinguish this subsection from the Outer Ozark Border Subsection, where they are absent. Local relief on the Jefferson City–Cotter Formation is significantly lower than in adjacent hill belts. Relief averages 150–250 feet but is higher where streams are more deeply entrenched. Slopes are less steep, ridges are somewhat smoother, and valleys are broader than in adjacent regions, where rock is more resistant. Nevertheless, bluffs are prominent along all major streams. The nearby Missouri and Mississippi Rivers provide a low base level so that long-term stream erosion is relatively vigorous in this subsection. Pennsylvanian sandstones and shales underlie flattish ridges in Osage, Gasconade, and Franklin Counties. Sinkholes occur sporadically in the soluble dolomites. Loess mantles the ridges near the Missouri River and helps to distinguish the subsection from hilly subsections to the south where loess is not significant. Clay is mined in local pits in the Pennsylvanian shales. Quarries, active and historic, pock the Missouri River bluffs and other locations.

SOILS

Soils are diverse within this subsection and vary with parent material and landscape position. Silty loess deposits are very thick adjacent to the Missouri River and thin with distance from it. Soils formed in deep loess deposits include the well-drained Menfro series and the moderately well-drained Winfield series, both with silty clay loam subsoils. Soils farther from the Missouri River formed in thinner loess over dolomite residuum and include the Wrengart series, with a brittle subsoil layer similar to a fragipan but not as restrictive to roots. Steep backslope soils were formed in very cherty dolomite residuum and include the very deep, red, very cherty Goss soils. Dolomite glades include the shallow, clayey Gasconade soils. Several wide alluvial plains with silty soils are included in the subsection, including the Haymond series on low floodplains and the Freeburg series on low terraces.

HYDROLOGY

The subsection is extremely diverse hydrologically. It includes numerous small streams that drain to the Missouri and Mississippi Rivers as well as the lower reaches of large tributaries like the Osage, Gasconade, Meramec, and Whitewater Rivers. Stream valleys are deeply entrenched into the blufflands of the Missouri and Mississippi Rivers, and stream gradients of smaller streams are steep. Streams carry bed loads of gravel and sand and their channels are usually in gravel, except where very close to the Missouri River, where they are silty. Streamflow is highest in spring and lowest in fall. Streams are subject to flash floods and also may be subject to backflooding during high stages of the Missouri River. Small springs are present, but they are relatively insignificant as a contributor to total stream discharge. Some springs in Cooper and Jefferson Counties are saline. The subsection lacks natural ponds and lakes, but there are numerous stock ponds and some moderately sized lakes that have been built for residential developments. Stream water quality is subject to pollution from agricultural runoff and built-up areas. Groundwater is abundant.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The Inner Ozark Border was historically dominated by oak savannas, woodlands, and forests, with occasional glade and prairie openings. The density of the timber generally increased with the roughness of the land. Glades were exceptionally abundant in the Jefferson County vicinity. Pine and oak-pine woodlands were abundant on a local sandstone landscape in Ste. Genevieve County.

Current. Today the region is dominated by fescue pasture. Cropland spreads along alluvial plains and ridges. Timbered lands consisting mainly of dense second-growth oak forest tend to be associated with the roughest lands near stream valleys. Savannas, open woodlands, and glades have grown up in invasive woody species in the absence of fire. Old, solitary trees occur in current pastures.

Major Natural Community Types

Central Post Oak Dry Barrens (Savanna)

Post Oak–Blackjack Oak/Little Bluestem Dry Chert Woodland

White Oak–Black Oak Dry-Mesic Chert Woodland

Ozark Dolomite Glade

Chinquapin Oak–Ash (Eastern Red Cedar)/Little Bluestem Dry Dolomite Woodland

White Oak–Mixed Oak/Redbud Dry-Mesic Limestone/Dolomite Forest

Mixed Oak–Hickory/Dogwood Dry-Mesic Chert Forest

White Oak/Dogwood Dry-Mesic Chert Forest

Shortleaf Pine–Oak/Vaccinium Dry Sandstone Woodland

White Oak, Red Oak, Sugar Maple Mesic Dolomite Forest

Rare or Restricted Natural Communities. The dolomite glade/woodland complexes in Jefferson County are some of the largest and most unusual outside of the White River Hills ecoregion. However, eastern red cedar has invaded and severely closed in most of the glades; other glades are subject to growing urban development pressures. The LaMotte sandstone area around Hawn State Park also supports unique cliff communities. The once widespread oak savannas and woodlands either have been converted to pasture or have grown into dense forests. Because of their proximity to big rivers and the mixing of two aquatic systems, the lower ends of streams often have unique assemblages of aquatic species. Fens, sinkhole ponds, and other wetlands are virtually absent from the region.

NATURAL DISTURBANCES

Fire and grazing by bison, elk, and deer were partially responsible for the creation and maintenance of the glades and open woodlands indigenous to the region. Reintroduction of fire shows potential for restoration.

RARE OR ENDANGERED SPECIES

This region contains 285 records of 100 state-listed species. Federally listed species from the region include three stream-associated species: pink mucket *(Lampsilis abrupta),* Curtis' pearly mussel *(Epioblasma florentina* var. *curtisi),* and Topeka shiner *(Notropis topeka).* Indiana bat *(Myotis sodalis)* and decurrent false aster *(Boltonia asteroids* var. *decurrens)* each have one record of occurrence in the region. There are 20 species whose principal distributions in Missouri are within this subsection; most of these are associated with the sandstone cliffs of Ste. Genevieve County. A high number of listed species are also associated with the extensive dolomite glades and woodland complexes of the region as well as with the streams.

NATURAL AREAS

There are seven designated Natural Areas in the Inner Ozark Border. Four of these are associated with the unique sandstone cliff communities of Ste. Genevieve County: Hickory Canyons, Pickle Springs, Pickle Creek, and Orchid Valley. Two others protect sandstone glade and woodland communities in the same vicinity: LaMotte Sandstone Barrens and Botkins Pine Woods. Valley View Glades represents a dolomite glade/woodland complex.

PUBLIC LANDS

The subsection contains more than 22,000 acres of public land. More than 8,000 acres are within the Fredericktown District of the Mark Twain National Forest. The Missouri Department of Conservation owns more than 6,000 acres. Prominent Conservation Areas in the region are Ben Branch Lake, Clubb Creek, Pacific Palisades, Pickle Springs, Prairie Home, and Valley View Glades. There are more than 6,000 acres in Hawn, St. Francois, and Robertsville State Parks. There are also several privately owned preserves.

HUMAN GEOGRAPHY

Demographics. A variety of Indian nations occupied different parts of this subsection. Some parts were effectively occupied for very long periods of time. In the east, Illinois tribes occupied the land as settlers and hunters. Along the Missouri River were Missouris, Great and Little Osages, Sacs, and Foxes, as well as many peoples who used the river for transit. French were present in the eastern parts in the eighteenth century to get to and from lead mines, but not as permanent settlers. American farmers, some with slaves, established settlements in the eastern parts around 1800, began settlement along the Missouri River around 1810, and reached central Missouri before 1820. Within a short time, by 1830, the best lands were occupied. In the 1830s German immigrants began to settle in many parts of the subsection. Their settlements continued to grow in numbers and expand in size until by the end of the century much of the subsection was dominated by persons of German ancestry. Population grew rapidly in the last half of the nineteenth century and reached a peak in many rural parts just before or at the turn of the twentieth century. Rural population began to decline with farm consolidation and mechanization, except for those areas close to urban employment centers. The urbanizing counties of Jefferson, Franklin, and Cole have experienced large population increases in the latter part of the twentieth century.

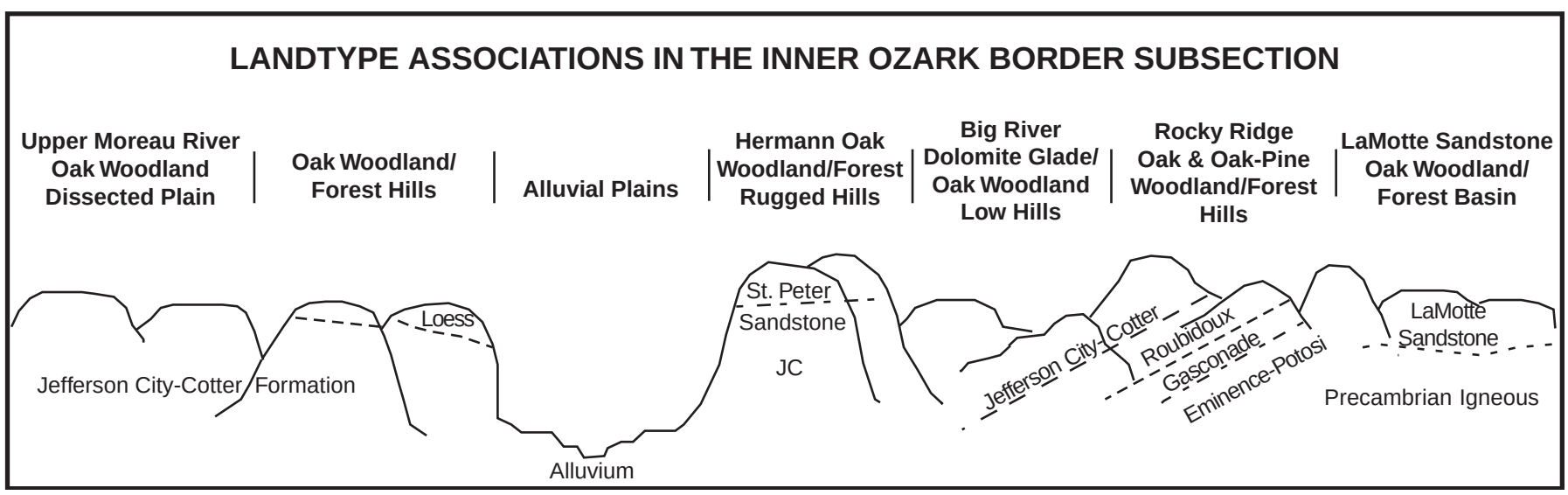
Economics and Land Use. Early nineteenth-century farming included small fields of corn and other crops, and cattle and hog raising. German immigrants introduced wheat to loess-capped ridges and gentler hillsides. Agriculture has changed in the twentieth century. Row crops have declined remarkably; cattle (beef and dairy) and hog raising and haying have prospered. Marginal farms have reverted to woodland or become pastures. River towns that were important before railroads have grown slowly in the twentieth century. Much of the land has been cleared for agriculture, chiefly pasture and hay crops. Row crops are restricted to bottomlands and the best soils. Woodlands, sometimes grazed, and forests occupy the steeper slopes. Residential and commercial land increasingly occupies parts of Cole, Franklin, and Jefferson Counties. Residential lake developments are growing in number. The economy of much of the subsection is supported by proximity to the St. Louis metropolitan area and to regional growth centers of Cape Girardeau and Jefferson City. Boonville, Hermann, Washington, Union, and DeSoto are local centers of business, services, and manufacturing. Today, agriculture is small-scale and secondary in importance and centers on livestock raising.

LANDTYPE ASSOCIATIONS

The Inner Ozark Border Subsection is subdivided into sixteen landtype associations (LTAs). They range from typical rolling to rugged woodland/forest hills along stream valleys, through unusual low hills with common dolomite glades, to broad, flat alluvial plains. The LTAs are illustrated on a map and described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Inner Ozark Border is interlaced by an exceptional number of roads with associated towns, all with significant development pressures. Proximity to the big rivers has fostered human use of this ecoregion for a long time. Consequently, the varied native ecosystems of the region are largely fragmented and somewhat degraded. The savannas, open woodlands, and glades formerly characteristic of the region are largely overgrown with invasive woody species and have a diminished ground flora diversity. Restoration of ecosystems with prescribed fire shows high potential for success, with the coincident enhancement of grazing and timber resources. Large blocks of forest associated with more rugged valleys are limited in extent, but they could be focal areas for forest conservation efforts. The streams have outstanding aquatic assemblages that deserve attention. By including natural resources in the long-term development strategies for the region, many of the aspects that make it special could be sustained.



(see landtype associations map pgs. 174–177)

LANDTYPE ASSOCIATIONS IN THE INNER OZARK BORDER	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ13a Moniteau Creek Woodland/ Forest Hills	The LTA occupies hills of the Moniteau Creek basin where it occurs on the Jefferson City–Cotter Formation. Most of boundary encompasses hills with greater than 150 feet of local relief and separates them from gentler plains. The northern boundary at Wooldridge is based on a change in lithology. The southeastern border is the drainage divide with the Moreau River.	The LTA consists of rolling to moderately steep hills formed in loess over Ordovician Jefferson City–Cotter dolomites. Local relief is 150–250 feet. Soils include fragipan soils in loess over dolomite residuum, poorly drained footslopes, and steep, droughty soils in cherty dolomite residuum. Historically, the LTA was timbered with oak woodland high in the landscape, grading into mixed-oak and mixed-hardwood forests in lower positions. Today, the region is mainly cleared pasture with scattered cropland on smooth ridges and in bottoms. Small patches of second-growth timber and dense cedar-hardwood old-field thickets are scattered throughout. The creek contains the federally listed Topeka shiner and several other rare fish species. Urban expansion is occurring around Jefferson City.
OZ13b Upper Moreau River Oak Woodland Dissected Plain	The LTA occupies a slightly dissected plain on the upper reaches of both forks of the Moreau River west of Jefferson City. Boundaries are drawn to separate the dissected plain with 100–150 feet of local relief from the flatter plains to the west and the hills to the north and south.	The LTA occupies an area of transition from the upland prairie plains to the west to the more rugged, timbered hills along the Missouri River. Broad, gently rolling, loess-covered divides give way to moderately dissected plains with broad valleys and moderate sideslopes and a local relief less than 150 feet. Historically, the LTA was oak savanna and woodland high in the landscape and mixed-oak forest at lower positions. Today, the LTA is mainly cleared pasture with scattered cropland on ridges and in bottoms. Small patches of second-growth timber and dense cedar-hardwood old-field thickets are scattered throughout. Urban expansion occurs in the Jefferson City area.
OZ13c South Fork Moreau River Woodland/Forest Hills	The LTA occupies the hills along the lower Moreau River south of Jefferson City. The southern boundary is a drainage divide with the Osage River basin, which is conspicuous in the landscape because of the much rougher land along the Osage River. The northern and western boundaries mark a transition to dissected plains with less than 150 feet of local relief. Other boundaries are with the Missouri and Osage River alluvial plains.	The LTA consists of moderately broad, loess-covered ridges on Jefferson City–Cotter dolomite that give way to steep slopes and valleys with 150–250 feet of local relief. The lower Moreau River valley cuts into the Roubidoux Formation. Historically, the LTA was timbered with oak woodland high in the landscape, grading into mixed-oak and mixed-hardwood forests in lower positions. Today, the region is mainly pasture for dairy and beef cattle with scattered cropland on ridges and in bottoms. Small patches of second-growth timber and dense cedar-hardwood old-field thickets and overgrown glades are scattered throughout. The LTA includes much of Jefferson City and experiences development pressures from its urban expansion.
OZ13d Osage-Gasconade River Oak Woodland/Forest Hills	The LTA occupies the hills between the lower Osage and lower Gasconade Rivers, and between the lower Gasconade River and Boeuf Creek, but excluding the steeper hills bordering the Missouri River. The southern boundary marks the transition to adjacent subsections that lack a loess influence and are dominated by Roubidoux and Gasconade Formations. The northern boundary is placed where deep loess covers the ridges and hills. The eastern boundary marks a transition to lower-relief hills. The alluvial plains of the Osage and Gasconade Rivers are excluded.	The LTA consists of moderately broad ridges with thin loess over Pennsylvanian sandstone and shale that give way to steep slopes and valleys. Local relief is 150–250 feet. The deepest valleys are cut through the Jefferson City–Cotter Formation into the Roubidoux Formation. Historically, the LTA was timbered with oak savanna and woodland high in the landscape, grading into mixed-oak and mixed-hardwood forests in lower positions. Today, there is an even mix of fescue pasture on flatter upland and lowland surfaces and dense second-growth timber on sideslopes. Dense cedar-hardwood thickets in old fields and on overgrown glades are scattered throughout.
OZ13e Osage County Loess Woodland/ Forest Hills	The LTA occupies a narrow belt of hills bordering the Missouri River between the Osage and Gasconade Rivers. The northern boundary is the Missouri River alluvial plain. The southern boundary marks a reduction in the loess cover and in the significance of loess to soils and ecosystems.	The LTA consists of a belt of deeply dissected, deep loess-covered hills. Relative relief is above 250 feet. The depth of valleys is due to proximity to the low base level of the adjacent Missouri River. Loess is generally from 3–10 feet deep on ridges, and considerable loess has washed into ravines and valleys. Sideslopes are in residual soils formed mainly from cherty dolomites. Historically, the LTA was timbered with oak woodland high in the landscape that graded into mixed-oak and mixed-hardwood forests in lower positions. Large blocks of second-growth forest are associated with the roughest lands, especially ravines opening to the Missouri River valley. Overgrown glades are frequent on steep sideslopes. The balance is in pasture or scattered cropland.

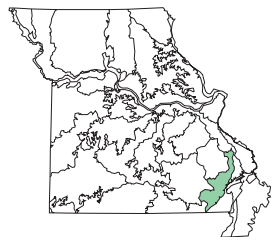
(table continued on pg. 146)

LANDTYPE ASSOCIATIONS IN THE INNER OZARK BORDER	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ13f Hermann Oak Woodland/ Forest Rugged Hills	The LTA occupies a small area of rugged hills around Hermann on the Missouri River. Boundaries are drawn to encompass a local area of rugged topography with relief over 250 feet.	The LTA is a small area of rugged hills capped with loess and Pennsylvanian and Ordovician sandstones; sideslopes and valleys are in Jefferson City–Cotter dolomite. Local relief is over 250 feet. Sandstone outcrops in ledges with unique glade, woodland, and forest complexes. Soils on sideslopes are cherty loams. Bluffs along the Missouri River are noticeably higher than upstream and downstream. Historically, the LTA was oak woodland and sandstone glades high in the landscape, and oak or mixed-hardwood forest in low positions. Today, the landscape has numerous residences and farms nestled among timbered hillsides. Valley bottoms and high flats are mainly pasture. Glades tend to be overgrown with eastern red cedar.
OZ13g Lower Osage River Alluvial Plain	The LTA occupies the lower 7 miles of the Osage River alluvial plain. The upper boundary is placed where the enclosing bedrock bluffs change to Roubidoux and Gasconade Formations. The boundary also marks the change from deep water in the Osage River to shallow with frequent shoaling conditions.	The LTA consists of a flat alluvial plain. Soils are deep and loamy alluvial soils. Historically, the LTA was timbered in bottomland forest; today it is mainly cropland with increasing recreational interests. The upper boundary is where a former dam for navigation was located; it tends to limit the upstream effect of backwatering and aquatic mixing from the Missouri River. Although flow is affected by varying discharges from Bagnell Dam, the elevation of the Osage River is largely controlled by the level of the Missouri River. Several rare fish and mussel species are known from this reach.
OZ13h Lower Gasconade River Alluvial Plain	The LTA occupies the lower 20 miles of the Gasconade River alluvial plain. The upstream boundary is placed where the plain narrows at a change in lithology to Roubidoux and Gasconade Formations near MO 50.	The LTA consists of a flat alluvial plain. Soils are deep and loamy alluvial soils. Historically, the LTA was timbered in bottomland forest; today it is mainly cropland. Several rare fish and mussel species are known from this reach.
OZ13i Franklin County Oak Woodland/Forest Low Hills	The LTA occupies a broad belt of gently rolling hills on the southern side of the Missouri River from the western Franklin County line east to near Gray Summit. The northern boundary is the Missouri River alluvial plain. The western boundary marks a rise to higher relief. The eastern boundary marks a change to Mississippian strata and an increase in relief. The southern boundary marks a transition to hills that lack a loess influence and are underlain by Roubidoux and Gasconade Formations.	The LTA consists of broadly rolling low hills with 100–200 feet of local relief almost entirely underlain by Jefferson City–Cotter dolomite with a loess veneer. Soils are mainly deep silt loams with a strong loess influence. Shallow soils on dolomite occupy steep sideslopes. Historically, the LTA was timbered with oak woodland high in the landscape, grading into mixed-oak and mixed-hardwood forests in lower positions. Today, the landscape is mainly fescue pasture with numerous areas of cropland in bottoms or flatter uplands. Most tracts of timber are small, isolated woodlots influenced by adjacent grazing lands. Cedars have spread in pastures and woodlands. The LTA has numerous small towns and roads with associated development pressures.
OZ13j Pacific Alluvial Plain	The very small LTA occupies a 3-mile reach of the alluvial plain of the Meramec River and tributaries at Pacific in eastern Franklin County. Boundaries include the alluvial plain where it is at least a 0.5 mile wide. The eastern boundary with the Outer Ozark Border Subsection marks a change in lithology.	The LTA consists of flat alluvial plains of the Meramec and tributaries before the river enters the Burlington Escarpment with its more resistant dolomites. Soils are mainly deep and loamy alluvial soils with variable amounts of gravel and are subject to flooding. Historically, the LTA was timbered in bottomland forest; today it is mainly cropland and urban development related to Pacific and I-44.
OZ13k Big River Dolomite Glade/Oak Woodland Low Hills	The LTA is a belt of low hills in eastern Franklin County and through the length of Jefferson County. In terms of evolutionary geomorphology the LTA occupies a strike valley at the base of the Burlington Escarpment. Boundaries are drawn to encompass a region of low hills associated with the Jefferson City–Cotter Formation. The long western boundary is placed where the Jefferson City–Cotter Formation gives way to others. The northeastern boundary is a sharp rise to the top of the Burlington Escarpment. The eastern boundary is the Mississippi River alluvial plain. The northern boundary is the drainage divide between the Meramec and Missouri Rivers. The southern boundary is quite arbitrary, representing a slight change to rougher lands.	The LTA consists of low hills with local relief generally 150–200 feet but increasing to more than 250 near the Meramec and Big Rivers and Joachim and Sandy Creeks. Slopes are moderate. Soils are generally deep, cherty clay loams, but extensive areas have shallow soils over dolomite bedrock. Glade/woodland complexes occur on shallow soils and bedrock ledges on sideslopes, especially near the stream valleys. Historically, the LTA had glade/woodland complexes interspersed within a matrix of oak woodland. Today, most of the glades and woodlands are overgrown with eastern red cedar. Local restoration efforts have proven successful. Upland ridges and bottoms are mainly pasture with occasional cropland. The LTA is highly urbanized in parts nearer St. Louis and along highway corridors. Urbanization of this landscape is widespread, especially near towns such as Cedar Hill, Hillsboro, DeSoto, and Festus.

LANDTYPE ASSOCIATIONS IN THE INNER OZARK BORDER	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ13l Big River Alluvial Plain	The LTA occupies a 12-mile reach of the Big River alluvial plain across the Big River Dolomite Glade/Oak Woodland Low Hills LTA. The boundaries are the limits of the alluvial plain. The downstream boundary is placed where the Big River enters the high-relief Meramec Hills of the Inner Ozark Border. The upstream boundary is placed where the valley is narrower and cut into the Roubidoux Formation.	The LTA consists of the flat alluvial plain, which is at least a 0.5 mile wide. Soils are mainly deep and loamy with variable amounts of gravel. Historically the LTA was timbered in bottomland forest, but today it is mainly cropland and pasture.
OZ13m Rocky Ridge Oak and Oak-Pine Woodland/Forest Hills	The LTA occupies a long narrow belt of hills of complex geology on the northeastern edge of the St. Francois Knobs and Basins Subsection. Boundaries are drawn to encompass an area of high relief (above 250 feet of local relief) associated with Paleozoic sedimentaries older than the Jefferson City–Cotter Formation. This elongated belt of hills is known as the Crystal Escarpment. The western boundary marks the change to lower relief on sandstone strata. The eastern boundary marks the Jefferson City–Cotter dolomite, also a landscape of lower relief. The northern and southern boundaries are drawn where relief declines.	The LTA consists of a long narrow belt of rugged hills underlain by various rock types that are all much more resistant than the strata to the west and east. Local relief is over 250 feet and more commonly over 300 feet. From west to east, geologic formations include Cambrian Bonne Terre and Eminence-Potosi, then Ordovician Roubidoux and Gasconade, all mostly carbonate with some prominent sandstones. High-gradient streams cross the belt in a transverse pattern, flowing in many reaches on bedrock. Historically, the LTA was oak and oak-pine woodland and forest. Today, it is mainly timbered in dense second-growth mixed-oak forest with scattered oak-pine forest; cleared pasture is minimal. The LTA includes Hickory Canyons Natural Area, Hawn State Park, and substantial USDA Forest Service land.
OZ13n Kinsey Oak Woodland/ Forest Hills	The LTA occupies a long narrow landscape of hills from south Jefferson County through Ste. Genevieve County as far as southern Perry County, on the Jefferson City–Cotter formation from south of Festus southeast to near Perryville. Boundaries are drawn based on differences in relief and lithology. The northeastern boundary marks a change in lithology and abrupt relief. The southeastern boundary clearly marks a dissected plain of much lower relief associated with younger Ordovician limestone. The western boundary separates the rugged hills of much higher relief on resistant, older strata.	The LTA consists of a varied landscape of gently rolling hills with occasional belts of more rugged topography where streams cut through the belt. Local relief is 100–150 feet, with some areas over 250 feet. The LTA is underlain by the Jefferson City–Cotter Formation, with minor areas of Roubidoux and Gasconade and a small area of later Ordovician and Devonian formations associated with a complex fault zone. Soils vary, but most are cherty. Historically, the LTA was oak woodland and forest with scattered dolomite glades on thin-soil slopes near valleys. Today, the region is a nearly equal mix of pasture, especially in the valleys, and second-growth oak timber. Dense cedar thickets have encroached into the glades. Minimal cropland occurs on valley floors.
OZ13o LaMotte Sandstone Oak Woodland/Forest Basin	The LTA occupies a dissected plain on the divide between streams flowing west to the St. Francis and east to the Mississippi River. Boundaries are drawn to encompass the area associated with LaMotte sandstone. The western boundary marks a transition to a low-relief plain on chert-free limestones. The eastern boundary marks a rise into very rugged hills.	The LTA consists of a gently rolling divide that geologically and geomorphologically is an extension of the Farmington Basin to the west, but because of its greater relief it is physiographically and ecologically attached to the Inner Ozark Border Subsection. The LTA is virtually coincident with the exposure of Cambrian LaMotte sandstone. Local relief is essentially 75–150 feet, except along valleys, where it can rise to 200 feet. Soils are noticeably sandy and less productive for agriculture than the limestone and dolomite soils of the Ozarks. Historically, the LTA was a mixture of oak and oak-pine woodland, with occasional sandstone glades and mesic sandstone canyons. Today, it is largely cleared pasture, except for timbered areas where the land is more rugged. Pickle Springs and Orchid Valley Natural Areas and Hawn State Park harbor many unique sandstone features.
OZ13p East Bollinger Oak Woodland/ Forest Hills	The LTA occupies a long belt of hills in eastern Bollinger County and a minor portion of adjacent Cape Girardeau County. Boundaries are drawn to encompass a hilly landscape on the Jefferson City–Cotter Formation. The southern boundary is the Ozark Escarpment with the Mississippi lowlands.	The LTA consists of broad, rolling uplands that give way to strongly sloping lands near streams with broad valleys. Local relief is 150–250 feet. Soils are cherty loams with a thin loess layer close to the Ozark Escarpment. Historically, the LTA was oak woodland and forest with the density of trees increasing with surface roughness. Today, valley bottoms and broad ridges are mainly in fescue pasture with occasional cropland, which is more common in the valleys leading to the Ozark Escarpment. The balance is second-growth oak timber on rougher lands. There are very few public lands or heritage records.

OZ14
BLACK RIVER OZARK BORDER SUBSECTION

(see map pg. 178–179)



GENERAL DESCRIPTION

This subsection consists of moderately dissected hills with local relief up to 300 feet, and local flatwoods of much less relief. Soils on steeper slopes are deep, cherty silt loams, and elsewhere they have claypans formed in loess over cherty residuum. Presettlement vegetation was oak and pine-oak woodland and forest, with post oak flatwoods on high, flat areas. Most of the land is in forest with cleared land restricted to valley bottoms. A substantial amount of public land exists here.

LOCATION AND BOUNDARIES

This subsection lies in the Ozarks of southeastern Missouri. It comprises major portions of Wayne and Butler Counties and smaller portions of St. Francois, Ste. Genevieve, Madison, Bollinger, Carter, and Ripley Counties. The southeastern boundary is the linear Ozark Escarpment, a very conspicuous boundary between the Ozark Highlands and the Mississippi River Alluvial Plain Sections. The eastern boundary with the Inner Ozark Border Subsection lies in a transition zone and is drawn using a generalized boundary between soils derived from sandstone (Black River Ozark Border Subsection) and those derived from limestone (Inner Ozark Border Subsection). The northern boundary with the St. Francois Knobs and Basins Subsections is drawn in such a way as to exclude from this subsection the igneous and Cambrian geologic materials to the north. It is not a very clear boundary except in the Patterson-Piedmont area, because the pattern of igneous and sedimentary formations is complex. The western boundary with the Current River Hills Subsection is drawn where the lower local relief of this subsection increases to more than 250 feet. Along the Black River this is transitional. In the drainage divides on both sides of the Black River, where the boundary extends farther northwestward, the boundary is sharper and marked by prominent local erosional escarpments. The southwestern boundary with the Central Plateau Subsection is drawn to exclude the low-relief, Jefferson City–Cotter plain to the west. The subsection extends, fingerlike, southward along the crest of the Ozark Escarpment slightly into Arkansas.

CLIMATE

Mean annual precipitation is 49 inches. Precipitation is well distributed through all months of the year. Slightly more occurs during the months of March–May and November–December, and the months of October and January tend to be the driest. Annual snowfall averages 10 inches. Mean January minimum daily temperature is 21–22°. Mean July maximum daily temperature is 91°. The growing season averages 215–225 days. Microclimatic variations are locally significant due to the moderately high relief of the subsection.

TOPOGRAPHY AND GEOLOGY

This subsection lies on the southern flank of the Ozark uplift. Strata dip gently southward across the subsection. The subsection is everywhere underlain by thick cherty dolomites and sandstones of the Ordovician Gasconade and Roubidoux Formations. The dolomites are soluble and create karst conditions, even though signature features like sinkholes and caverns are much less common than in most of the Ozarks. Solution and decompositional residuum is very thick (more than 50 feet) and is a clay matrix with considerable rock fragments, chiefly chert. Where stream dissection is weak, as in low-relief localities called flatwoods, impeded drainage occurs in the soil and residuum. Elsewhere, slopes are relatively steep and rocky. Local relief in the dissected parts is up to 300 feet, but still significantly less than the hillier subsections of the Ozarks to the north and west. Loess mantles the ridges and slopes along the Ozark Escarpment.

SOILS

Soils in this subsection are mostly deep to very deep and formed in residuum from Ordovician dolomite. Interfluve soils have a thin veneer of loess over the residuum, and deep loess soils occur along the southeastern border, above the Mississippi lowlands. Soils on interfluve positions include the moderately well-drained Captina series, with a root-restricting fragipan in the very gravelly residuum below the silty clay loam loess subsoil. The very gravelly Scholten soils formed in residuum, have fragipan, and are on convex summits and shoulders. Backslopes are dominantly very deep, red, cherty soils, such as Clarksville and Poynor.

HYDROLOGY

The subsection extends across portions of several southward-flowing drainage systems, including those of the Whitewater, Castor, St. Francis, Black, and Little Black Rivers, but it does not include the largest portion of any. Many streams are intermittent or ephemeral in flow; the larger ones are perennial. Their discharge is, on average, highest in late winter and spring and declines rapidly in the summer and stays low through autumn. High-intensity rains and protracted rains may cause serious floods at any time of the year. Flooding on the Black River is mitigated by Clearwater Dam and Lake. The St. Francis River in much of this subsection has been drowned by Lake Wappapello. Smaller streams have high gradients. Streams carry large bedloads of gravel and sand, and gravel and sandbars are the rule in all channels. The streams carry remarkably little suspended sediment. The channels of streams for the last several miles before they reach the Ozark Escarpment are silty, and their bottomlands tend to be wet, due to reduction in stream gradient, backwater flooding from the Mississippi lowlands, and resulting silt deposition. Springs are common in the subsection, and some are large and major contributors to the base flow of perennial streams. The subsection lacks natural ponds and lakes, except for sinkhole ponds, but many ponds have been built for stock watering and other purposes. Stream water quality is basically good. Groundwater is very abundant and generally of very high quality, although high in alkalinity.

TERRESTRIAL NATURAL COMMUNITIES

Historic. This region formerly had large expanses of open shortleaf pine and pine-oak woodlands, especially in minimally dissected areas on Roubidoux sandstone. Post oak flatwoods occupied the flat uplands with thick loess deposits along the southeastern border. Mixed-oak woodland and forest occupied protected slopes near valleys. Mixed bottomland hardwood forest and swamp were prevalent in wet bottomlands near the Ozark Escarpment. Glades, fens, and sinkhole ponds were rare and scattered.

Current. Most of the region is still timbered in dense second-growth oak and oak-pine forest. The amount of pine has diminished from earlier times, and many scarlet and black oak stands have suffered oak dieback. Ground flora diversity associated with open woodlands is low. Fescue pasture commonly occupies cleared alluvial plains and high flats, especially in the northeastern part of the ecoregion.

Major Natural Community Types

Post Oak Flatwoods

Post Oak–Blackjack Oak/Bluestem Dry Chert Woodland

The Black River Ozark Border Subsection was home to the largest sawmill in the world at the turn of the twentieth century, leading to the removal of the abundant shortleaf pine that was there.

Missouri Department of Conservation

Post Oak, Black Oak, Scarlet Oak Dry Chert Woodland

Shortleaf Pine/Bluestem Dry Chert Woodland

Shortleaf Pine–Oak/Vaccinium Dry Chert Woodland

Mixed Oak–Hickory/Dogwood Dry-Mesic Chert Forest

White Oak/Dogwood Dry-Mesic Chert Forest

Swamp Chestnut Oak–Sweetgum Wet-Mesic Bottomland Forest (SEMO)

Rare or Restricted Natural Communities. High-quality, open post oak or pine and pine-oak woodlands with their diverse ground floras are rare or absent. Unique bottomland forest and stream communities that blend species of both the Ozarks and the Mississippi lowlands persist where streams exit the subsection. Springs, fens, and sinkhole ponds are rare, but several high-quality remnants are known.

NATURAL DISTURBANCES

Fire and to a lesser degree grazing had important influences on the creation and maintenance of the open woodlands once widespread across the region. Flooding probably played a role in the unusual mixing of Ozark and Mississippi lowland species.

RARE OR ENDANGERED SPECIES

The Black River Ozark Border Subsection has 329 records of 124 state-listed species in the heritage database. Five species are federally listed: Curtis' pearly mussel *(Epioblasma florentina* var. *curtisi),* bald eagle *(Heliaeetus leucocephalus),* pink mucket *(Lampsilis abrupta),* small whorled pagonia *(Isotria medelioides),* and running buffalo clover *(Trifolium stoloniferum).* Ten species have over 80 percent of their occurrences in Missouri within the subsection. Habitats supporting these and other species are streams and wetlands, upland and bottomland forest and woodlands, and fens.

NATURAL AREAS

The subsection has only three designated natural areas. Blue Pond is an outstanding sinkhole pond. Poplar Bluff Forest has state-significant bottomland forest and seep communities. Mud Creek supports an unusual mix of Ozarkian and Mississippi lowland species in a bottomland forest complex.

PUBLIC LANDS

The subsection includes more than 200,000 acres of public land, most of which are in the Poplar Bluff District of the Mark Twain National Forest (more than 130,000 acres). The U.S. Army Corps of Engineers owns almost 40,000 acres associated with Wappapello Lake. The Missouri Department of Conservation manages a substantial amount of the those lands, as well as over 30,000 acres of its own. Prominent Conservation Areas include Castor River, Coldwater, Flatwoods, Little Black, Mudpuppy, Poplar Bluff, and University Forest. Wappapello Lake is the only state park.

HUMAN GEOGRAPHY

Demographics. Indian occupation of the land before American settlement was mostly for hunting, which involved the burning of woodlands and forests. In the early decades of the nineteenth century, various eastern Indian nations lived temporarily in the subsection while moving to lands farther west. Americans, with slaves, began permanent settlement along the St. Francis River shortly after 1800, but most of the bottomlands were not entered until the 1820s and 1830s. The flatwoods resisted farm settlement until much later. The people who early settled the region were from Kentucky, Tennessee, and southern Appalachia. Population grew until about 1920 when decline set in, offset only in small part by the growth of Poplar Bluff. Rural sections arrested their population declines in the last two decades of the twentieth century.

Economics and Land Use. Early livelihoods were earned by farming small corn patches and using forests and woodlands for open-range cattle and hog raising. Farming stayed at a semisubsistence level until well into the twentieth century. Large-scale lumbering began toward the end of the nineteenth century and ended within two decades when the merchantable timber had been cut. The region was in the center of an extensive pine resource. At one time the largest mill in the world was at Grandin. Farming could not accommodate the surplus population from the collapsed lumber industry, and severe population losses took place. Farming has become almost completely livestock raising, with hay crops in river bottoms. The great majority of the land is in forest and woodland, some of it grazed. Pasture occupies most of the remaining land. Crops are restricted to loess on gentle slopes along the Ozark Escarpment and in bottomlands. Urban land use is in the Poplar Bluff vicinity. A livestock-based rural economy persists in the subsection. The timber-products industry has partially revived. Recreation is important at Lake Wappapello. Poplar Bluff has become a commercial and professional service center for a large region.

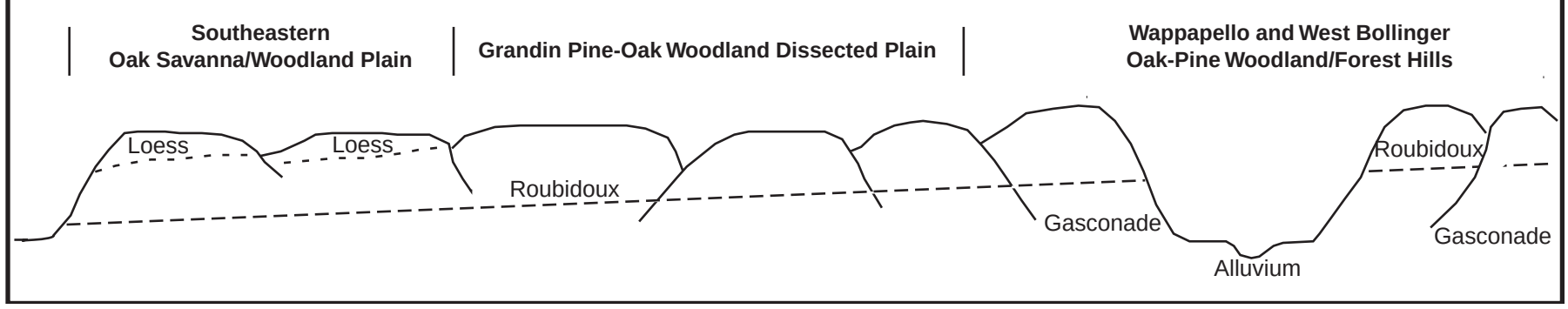
LANDTYPE ASSOCIATIONS

The Black River Ozark Border Subsection is subdivided into four landtype associations (LTAs). They include minimally dissected oak and pine-oak woodland dissected plains, as well as more rugged oak-pine hills. The LTAs are illustrated on a map and described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Black River Ozark Border still has a substantial amount of land in natural vegetation, and much of this is in public ownership. The structure and composition of native woodlands has been altered severely, however. Opportunities to restore pine and post oak woodlands using some timber harvest and prescribed fire should be emphasized. Large blocks of forest associated with more rugged valleys could be focal areas for forest conservation efforts. Protecting the rare and sensitive spring, fen, and sinkhole-pond communities should also be a priority. Finally, the streams of the region have outstanding aquatic assemblages as well as associated unique bottomland forest communities that deserve attention.

LANDTYPE ASSOCIATIONS IN THE BLACK RIVER OZARK BORDER SUBSECTION

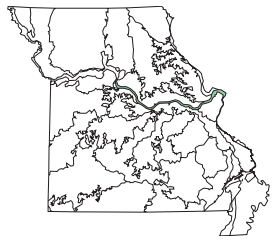


(see landtype associations map pg. 178–179)

LANDTYPE ASSOCIATIONS OF THE BLACK RIVER OZARK BORDER	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ14a Grandin Pine-Oak Woodland Dissected Plain	The LTA occupies a compactly shaped, dissected upland plain between the lower Black and Current Rivers. Boundaries are drawn on all sides (except the southeast) where local relief increases to more than 150 feet in surrounding hills. The boundary on the north at Ellsinore is a noticeably more abrupt change. The southeastern boundary is drawn where the plain becomes loess-covered and where slopes are gentler.	The LTA consists of a slightly dissected plain in which broad ridges give way to moderate slopes and broad stream valleys. Relief is 100–150 feet. Soils are ultisols based on Roubidoux and upper Gasconade Formations. The LTA formerly was a nearly pure to mixed shortleaf pine and pine-oak woodland. Grandin was the center for pine exploitation shortly after the turn of the century. Today, dense second-growth forest with a much diminished pine component and lower ground flora diversity dominates the landscape. Pastures occur on bottoms and occasionally on smooth upland ridges. About half of the LTA is in the Mark Twain National Forest.
OZ14b Southeastern Oak Savanna/ Woodland Plain	The LTA occupies a long, narrow, loess-covered plain bordering the Mississippi lowlands from near the St. Francis River southwest to the Arkansas line. Boundaries are drawn to encompass the slightly dissected plain with significant loess cover. The southeastern boundary is the abrupt and conspicuous Ozark Escarpment that separates the Ozarks from the lowlands.	The LTA consists of a slightly dissected upland plain with local relief generally of 100–150 feet. Divides are broad and smooth and underlain by the Roubidoux Formation. Valleys are broad and moderately steep sided. Loess mantles the entire region and gives it its distinction. Fragipans are common on the upland. Post oak and post oak–black oak flatwoods were historically widespread; absence of pine is noteworthy. Today, pasture dominates the landscape with numerous small, isolated patches of dense second-growth timber. Urban development pressures occur at Poplar Bluff.
OZ14c Wappapello Oak-Pine Woodland/Forest Hills	The LTA occupies hills associated with the lower Black, St. Francis, and Castor River watersheds within 30 miles of the Mississippi lowlands. The southern boundary is the Ozark Escarpment of the Mississippi lowlands, except where loess mantles the escarpment hills. The northern boundary with the St. Francis Knobs marks a change to Cambrian and Precambrian lithologies. The eastern boundary is drawn where local relief decreases to less than 250 feet. The western boundary is a prominent erosional escarpment that marks watershed divides.	The large LTA consists of moderately dissected hills with over 250 feet of local relief. Broad, moderately dissected uplands give way to steep slopes and ample valleys. Most of the uplands are underlain by the Roubidoux Formation, and the valleys are cut into the upper Gasconade Formation. Highly leached soils formerly supported extensive pine and pine-oak woodland, with oak woodlands on protected slopes. Bottomlands where streams meet the lowlands formerly supported a unique transitional bottomland forest of both Ozark and lowland species. Today the region is densely timbered in second-growth forest with the pine component diminished. Pasture dominates the larger bottoms. Several outstanding seep and fen complexes and sinkhole ponds are present. Unique stream communities occur throughout the LTA. Wappapello Lake is at the southern end of the LTA. The LTA includes major holdings of USDA Forest Service land and state public land.
OZ14d West Bollinger Oak-Pine Woodland/Forest Hills	The LTA occupies a long, narrow band of hills between the St. Francis Knobs and Basins and the Inner Ozark Border Subsections. The western boundary marks the contact with Cambrian and Precambrian lithologies. The eastern boundary marks the transition to Jefferson City–Cotter dolomites with lower relief. The northern boundary is a watershed line, and the southern boundary marks a transition to greater relief.	The LTA consists of moderately dissected hills lying partly in the headwaters of the Whitewater system and partly in the Castor system. Broad, moderately dissected uplands on the interfluves with relief of about 200 feet give way to more relief (greater than 250 feet) farther from the interfluves, where there are steep slopes and alluvial valleys. Most uplands are underlain by the Roubidoux Formation, while the valleys are cut into the upper Gasconade Formation. Highly leached soils formerly supported extensive pine and pine-oak woodlands with oak woodlands on protected slopes. Today, pasture is the prevailing land use on uplands and alluvial bottoms, while the numerous rugged ravines are still timbered in dense second-growth forest with much less pine than formerly. Some northern parts are in the Mark Twain National Forest. The LTA experiences little pressure from economic development.

OZ15
MISSOURI RIVER ALLUVIAL PLAIN SUBSECTION

(see map pgs. 174–177)



GENERAL DESCRIPTION

The subsection consists of the Missouri River channel and its adjoining alluvial plain across the northern Ozarks. Formerly the channel contained numerous islands and bars, but in the last half century it has been narrowed, its islands virtually eliminated, and its banks stabilized. Soils are deep and loamy. Presettlement vegetation was mostly bottomland forest dominated by riverfront species including willow, cottonwood, sycamore, elm, silver maple, and hackberry. True mixed-hardwood forests with oak, sugar maple, walnut, and bitternut hickory were limited to high terraces. The alluvial plain is subject to flooding, although many bottoms have some degree of levee protection. Today land use is chiefly row crops.

LOCATION AND BOUNDARIES

This clearly defined and sharply delimited subsection is located in central and east-central Missouri. It extends from Arrow Rock in Saline County to the junction of the Missouri and Mississippi Rivers eastern in St. Charles County. It includes very small portions of fourteen counties. Its boundaries on both sides of the Missouri River are the bluff lines. In eastern St. Charles County it is separated from the Mississippi River Alluvial Plain (of the Dissected Till Plains Section) by a pronounced alluvial terrace that separates the surface alluvium of the Missouri River from that of the Mississippi River.

CLIMATE

Mean annual precipitation is 40 inches. The wettest months are May–June and September, and 60 percent of the annual precipitation occurs during the six warmer months of the year (at Jefferson City). Annual snowfall averages 19–20 inches. Mean January minimum daily temperature is 17–18°. Mean July maximum daily temperature is 90°. The growing season averages 210 days. Microclimatic variations are not significant except over and adjacent to the river surface. Fog often forms in spring and fall due to temperature differences between the water and overlying air.

TOPOGRAPHY AND GEOLOGY

This subsection is defined as the channel and alluvial plain of the Missouri River within the Ozark Highlands Section. The river crosses the Ozark uplift on its northern flank, where strata are gently dipping to the north and northwest. Bedrock lies generally 50–100 feet below the surface and does not affect surface features or processes. Resistance of the bedrock, however, is principally responsible for the narrowness of the river's alluvial plain through the Ozarks in contrast to its greater width in western Missouri. The river channel is formed in late Pleistocene, Holocene, or Recent alluvium, much of it related to glaciation. Relief on the alluvial plain is very low, usually not more than 5–10 feet within a mile, except where an alluvial terrace occurs. Artificial levees up to 15 feet high protect most bottoms.

SOILS

Soils in this subsection are all very deep and were formed in alluvial sediments. Subsoil development is minimal in these relatively youthful soils, and textural stratification within the soil profile is common. Soil texture and drainage vary, depending on the position within the alluvial plain. Sandy soils, such as the excessively drained Sarpy series, occur in splay deposits near the river. Clayey soils, such as the poorly drained Waldron and Booker series, are in back swamp or slack water positions farther from the river. Silty soils, such as the well-drained Haynie series, are on natural levees. However, due to the shifting river channel, the relationships between soils and river location may not be apparent. Some soils have strongly contrasting textures within the soil profile, reflecting changes in river position. For example, Leta soils are clayey in the upper part and silty in the lower part. Alluvial sediments deposited by the Missouri River are calcareous, and therefore soils in the Missouri River alluvial plain have free carbonate rocks within the profile, with neutral to slightly alkaline pH values.

HYDROLOGY

The subsection contains the channel of the Missouri River across the Ozarks. Streams draining across the bottomlands from adjacent uplands are numerous. As a natural river, the Missouri formerly shifted its channel, repeatedly constructing and destroying islands and bars in a morphologically dynamic environment. Since the mid-twentieth century the channel banks have been stabilized and narrowed, making the river approximately half of its former width; additionally, most islands have been eliminated and the channel deepened. The bed and banks are mainly sandy and silty, and tributaries from the Ozarks bring in loads of gravel and sands at their junctions with the Missouri. The Missouri carries both an impressive bed load of coarse sediments and an impressive suspended sediment of fine sands, silts, and clays; both coarse and fine sediments are noticeably greater than in the upper Mississippi River at the junction of the two rivers. River depth at average discharge reaches over 20 feet in selected spots. A navigational channel 300 feet wide and 9 feet deep is maintained except during winter months. The river drops about 0.9 feet per mile across this subsection, and its average velocity is about 5 miles per hour. Average discharge at Hermann is 86,000 cubic feet per second. The average discharge of the river in its former natural state was six times greater in June (maximum) than in January (minimum). Discharge is now regulated by many large dams and reservoirs upstream on the Missouri and its tributaries, and seasonal fluctuations have been reduced. However, the U.S. Army Corps of Engineers, responsible for management of the river, is considering modifying the timing of river discharge. Most of the minor floods are held back by levees, but the height and strength of levees is not standardized, and some bottoms are not protected. Occasional extreme events submerge the bottoms and effect major changes in the landscape. Both the flood of 1844 (when there were no levees) and the Great Flood of 1993 created numerous "blue holes" and extensive sand deposits. High discharges also modify channel geometry significantly. Low discharges are possible during droughts, but management of the river for navigation lessens their severity. Ice can block the channel during severe winters. Bottomlands were formerly wet in places, but most wetlands have been drained. A few wetlands have been restored. Prominent oxbow lakes are in St. Louis and St. Charles Counties. Water levels in the lower courses of tributaries are controlled by the stages of the Missouri River and usually constitute a quiet, backwater fluvial environment that contrasts with the "open" channel of the swift-flowing Missouri River. Water quality of the Missouri River is considered poor, in general, because the river receives the runoff of an immense 525,000 square miles of land (at Hermann), including metropolitan areas and vast agricultural lands.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The dynamic system of braided and shifting channels with fluctuating water levels created a mosaic of ever-shifting communities, ranging from sandbars of bare ground to thickets of willow and cottonwood seedlings. With time, these developed into riverfront forests of willow, cottonwood, elm, hackberry, and silver maple. Most of the bottoms were apparently forested with this type of system. Marshes and shrub swamps occupied scoured swales and abandoned channels.

The floods of 1993 and 1995 in many places carved deep "blue holes" where the river attempted to reclaim its historic channel.

Jim Rathert

Theresa Kight

State and federal agencies have purchased substantial acreage of flood-damaged land along the Missouri River, where restoration of wetlands is being undertaken.

Mixed bottomland hardwood forests with oak, sugar maple, walnut, and bitternut hickory were limited to colluvial slopes, terraces, and other well-drained surfaces less subject to flooding.

Current. Most of this subsection has been cleared and is in row crops. Only the lowest, wettest areas and those unprotected by levees have small, isolated patches of natural vegetation. Public land acquisitions following the Great Flood of 1993 added substantial amounts of the bottomlands to restoration activities.

Major Natural Community Types

Riverine Sand Flats

Sycamore, Cottonwood–Black Willow Riverfront Forest

Southern Green Ash, Elm, Sugarberry Riverfront Forest

Pin Oak–Mixed Hardwood Wet Bottomland Forest

Red Oak, Sugar Maple, Bitternut Hickory Mesic Bottomland Forest

Rare or Restricted Natural Communities. This ecoregion may have had the largest expanses of riverfront forest and sandbars of all the big river systems in Missouri. The Missouri River comprised a unique aquatic ecosystem. All of its communities are rare today. The only record for a high-quality sandbar in the heritage database is from this ecoregion, and only two bottomland forest records are known.

NATURAL DISTURBANCES

Periodic flooding of different depths created cycles of wetland destruction and creation that resulted in a tremendously diverse ecosystem. Drought and freezing also played important roles in shaping the hydrology of these systems.

RARE OR ENDANGERED SPECIES

The Missouri River Alluvial Plain Subsection of the Ozark Highlands Section contains 202 records of 47 state-listed species. There are 143 records for 18 listed fish species; the remainder are mainly wetland plants and birds. Seven species are of federal concern, including bald eagle *(Heliaeetus leucocephalus),* decurrent false aster *(Boltonia asteroids* var. *decurrens),* gray bat *(Myotis grisescens),* Indiana bat *(Myotis sodalis),* pallid sturgeon *(Scaphirhynchus albus),* pink mucket *(Lampsilis abrupta),* and running buffalo clover *(Trifolium stoloniferum).* Umbrella flatsedge *(Cyperus diandrus)* is known only from two locations in this subsection within Missouri.

NATURAL AREAS

The subsection has only one designated Natural Area; Pelican Island is one of the few remaining islands in the river. It has outstanding sandbar and riverfront forest communities.

PUBLIC LANDS

The subsection has more than 40,000 acres of public land, most of which originated as flood-damaged lands following the Great Flood of 1993. The Missouri Department of Conservation owns more than 30,000 acres, including the Columbia Bottoms, Eagle Bluffs, Franklin Island, Howell Island, Marais Temps Clair, Pelican Island, Overton Bottoms, Plowboy Bend, and Smokey Waters Conservation Areas. The U.S. Fish and Wildlife Service manages more than 7,500 acres of refuge in the subsection, including Diana Bend, Jameson Island, Lisbon Bottoms, and St. Aubert's Island. Katy Trail State Park extends through the length of this subsection.

HUMAN GEOGRAPHY

Demographics. Indians had numerous camps along the river and used the river as a travel corridor for long periods of time. French also used the river for travel in the fur trade in the eighteenth century. A few French settlements, more for trade than for agriculture, were established along the lower course of the river before 1800. Americans entered the valley around 1800 and set up small agricultural settlements, where they raised corn and other crops in small fields and raised cattle and hogs on adjacent lands. The bottomlands were fully occupied by the beginning of the twentieth century, but farm population decline set in at midcentury. Nonfarm population continues to grow near river bridges.

Economics and Land Use. The bottoms began to be cleared wholesale in the 1830s and 1840s, shortly after the adjacent loess blufflands were settled. Delay in occupying the bottomlands was probably due to fear of malaria and the difficulty of cutting bottomland timber. By the turn of the century the alluvial plain was almost everywhere croplands. Riverbank timber was also cut for steamboat fuel, and this action may have aggravated bank instability. Towards the end of the twentieth century most farmers had moved their residences off the flood-prone plain, but it still remained in high-yielding cropland, chiefly soybeans, corn, and wheat. In St. Louis and St. Charles Counties, urban land uses have boldly encroached onto the alluvial plain, increasing property values and requiring higher, stronger levees in those areas. In some localities the alluvial plain is being returned to public wetland.

LANDTYPE ASSOCIATIONS

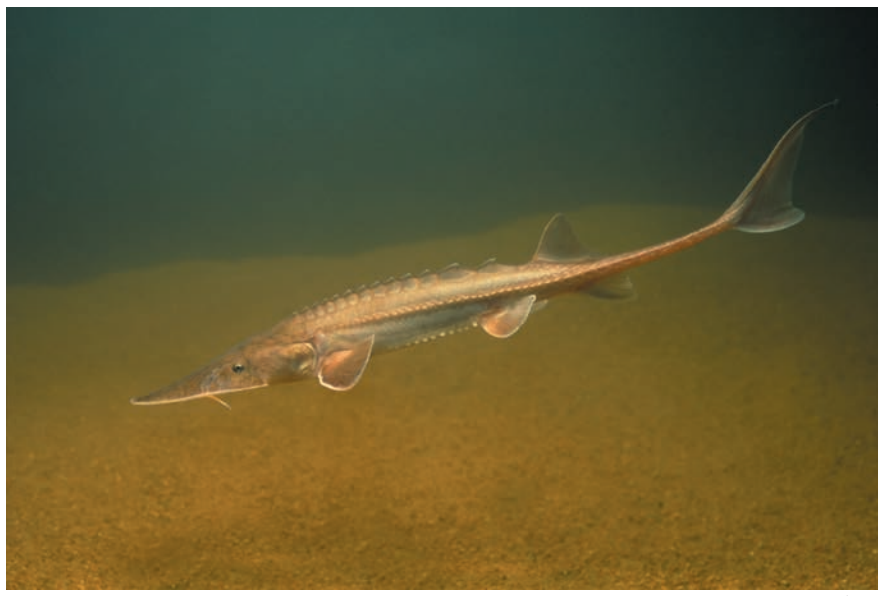
The Missouri River Alluvial Plain Subsection is subdivided into three landtype associations (LTAs). These include the relatively narrow floodplain of the river within the Ozarks, and the two broader floodplains near the confluence. The LTAs are illustrated on a map and described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Missouri River Alluvial Plain, like most large alluvial plains in the state, has been severely altered by channelization of the river and the draining and conversion of the alluvial plain to agriculture. Natural hydrologic processes are altered and very little natural vegetation remains. However, recent acquisition and management efforts are illustrating the resiliency of this ecosystem. Allowing for some conservation lands to act as flood storage during high water and emulating the natural hydrography in river management will promote native species and ecosystems. Finding ways for agriculture and native ecosystems to coexist in the alluvial plain and for commercial river navigation and aquatic ecosystems to coexist in the river channel will be key to future conservation success.

(see landtype associations map pg. 174–177)

LANDTYPE ASSOCIATIONS IN THE MISSOURI RIVER ALLUVIAL PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ15a Lower Missouri River Alluvial Plain	The LTA occupies the Missouri River alluvial plain from Arrow Rock to St. Charles. The western boundary is placed where the river narrows as it crosses the Burlington Escarpment into the Ozarks. The eastern boundary is placed where the alluvial plain widens and begins to merge with the Mississippi River alluvial plain. Conspicuous bluffs line the LTA on both sides.	The LTA consists of a river channel half of its former width and of a relatively narrow alluvial plain restricted by bluffs cut into Ozark bedrock materials, primarily dolomites and limestones. Bluff faces have been sharpened by quarrying and by railroad construction at their base. Considerable loess and other sediments have been washed down from the blufflands onto the alluvial plain. Soils are dominated by loamy, well-drained alluvium that was historically timbered. Today, this region is over 95 percent in row crops and levee-protected to varying heights. Industrial development, protected by the highest levees, is concentrated in the bottoms of St. Louis County. Many new public acquisitions of flood-damaged land are in this reach of the river.
OZ15b Marais Temps Clair Alluvial Plain	The LTA occupies the broad plain of the lower reach of the Missouri River from St. Charles downstream to Portage des Sioux. The southern boundary is the bluff in St. Louis County. The northern boundary is a prominent high terrace that separates the lower-lying Missouri River alluvial plain from sediments deposited by the Mississippi River. Missouri River flooding ordinarily does not extend north of the terrace.	The small LTA consists of the narrowed and stabilized Missouri River channel and a broad, alluvial plain created by the Missouri River. Historically the LTA was bottomland prairie and long, sweeping marshes (Marais Temps Clair and Marais Croche) in partially filled oxbows that shared space with bottomland forest. Today it is almost completely cropland with encroaching urban development. Its flood-prone nature so far has precluded industrial development.
OZ15c West Alton Alluvial Plain	The LTA occupies a moderately broad alluvial plain between the Missouri and Mississippi Rivers below Portage des Sioux and a small portion south of the Missouri River (Columbia Bottoms). Boundaries are drawn to encompass the area of most recent alluvial construction by both rivers at their confluence.	The small but distinctive LTA is an alluvial plain at the confluence of the Missouri and Mississippi Rivers that receives frequent floodwaters and alluvium from both rivers, but mainly from the Missouri. Soils are recent and immature. Historically the LTA consisted of bottomland prairie and wetland complexes. Today it is in row crops and a major restored wetland with very limited residential and commercial development due to frequent flooding. Public lands are on both sides of the mouth of the Missouri River.

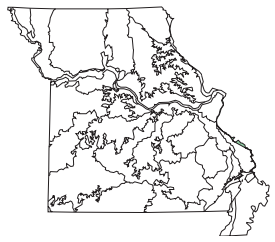


Jim Rathert

The pallid sturgeon is a federally listed endangered species in the channelized Missouri River.

OZ16
MISSISSIPPI RIVER ALLUVIAL PLAIN SUBSECTION

(see map pg. 176–177)



GENERAL DESCRIPTION

This subsection consists of the Mississippi River channel and its adjoining alluvial plain from just south of its confluence with the Missouri River south through the Ozarks to the Mississippi River Alluvial Basin section at Cape Girardeau. Channel banks have been stabilized for the most part. Soils are mainly formed in deep, loamy alluvium with places of poorly drained, finer-textured soils. Presettlement vegetation included both timber and wet prairie, but now it is mostly in cropland.

LOCATION AND BOUNDARIES

This clearly defined and sharply delimited subsection is located along the southeastern boundary of Missouri. It extends along the Mississippi River in disconnected land segments from just south of the mouth of the Missouri River in St. Charles County southward to the Mississippi River Alluvial Plain Section in Scott County. Small fragments occur in St. Charles, St. Louis, Jefferson, Ste. Genevieve, Perry, and Cape Girardeau Counties. All of these segments are linked by the river channel. The alluvial plain is much more extensive on the Illinois side of the Mississippi River. Subsection boundaries consist of the state line in the river and the bluff line that bounds the alluvial plain. The northern boundary is placed where the plain narrows at the northern extremity of St. Louis City. The southern boundary is placed where the Mississippi River exits from the Benton Hills at Commerce.

CLIMATE

Mean annual precipitation ranges from 40 inches in the north to 47 inches in the south. The wettest months are March–May and August, and 54 percent of the annual precipitation occurs during the six warmer months of the year (at Perryville). Annual snowfall ranges from 18 inches in the north to 12 inches in the south. Mean January minimum daily temperature ranges from 18° in the north to 22° in the south. Mean July maximum temperature is 90°. The growing season ranges from 210 days in the north to 215 days in the south. Microclimatic variations are not significant except over and adjacent to river surfaces. Fog often forms in spring and fall due to temperature differences between the water and overlying air.

TOPOGRAPHY AND GEOLOGY

This subsection is defined as the channel and alluvial plain of the Mississippi River within the Ozark Highlands Section. Bedrock lies deeper than 100 feet below the surface and does not affect surface features or processes. An exception is at Tower Rock, in southern Perry County, where shales and limestones project into the river channel. The bluffs are composed of a wide variety of sedimentary strata, but mostly dolomite and limestone. Loess and other sediments wash down from the blufflands onto the alluvial plain. The channel and alluvial plain are formed in late Pleistocene, Holocene, and Recent alluvium, much of it related to glaciation. Relief of the alluvial plain is very low, usually not more than 5–10 feet within a mile, except at a rise to an alluvial terrace. Artificial levees up to 20 feet high protect the larger alluvial bottoms.

Jim Rathert

Tower Rock is an isolated rock in the Mississippi River; seen by Lewis and Clark and others two hundred years ago, it remains a notable landmark for river travelers.

SOILS

Soils in this subsection are all very deep and were formed in alluvial sediments. Subsoil development is minimal in these relatively youthful soils, and textural stratification within the soil profile is common. Soil texture and drainage vary, depending on the position within the alluvial plain. Most soils are silty to clayey and are well to very poorly drained. Clayey soils, such as the poorly drained Darwin and Waldron series, are in back swamp or slack water positions. Silty soils, such as the well-drained Haynie series, are on natural levees. However, due to the shifting river channel, the relationships between soils and river location may not be apparent. Some soils have strongly contrasting textures within the soil profile, reflecting changes in river position. For example, Leta soils are clayey in the upper part and silty in the lower part.

HYDROLOGY

The subsection contains the channel of the Mississippi River from just above the mouth of the Missouri River to the entrance of the Headwaters Diversion Channel at Cape Girardeau and also a few minor streams on adjacent bottomlands. As a natural river, the Mississippi formerly shifted its channel and routinely constructed and destroyed islands and bars. Since the mid-twentieth century, channel banks have been stabilized, the channel narrowed, and some islands eliminated through channel engineering works. The bed and banks are silty and sandy. River depth reaches over 50 feet in selected spots. The U.S. Army Corps of Engineers maintains a navigation channel 300 feet wide and 9 feet deep. The alluvial bottoms were formerly wet in places, but they have been artificially drained so that few natural wetlands remain. A major channel avulsion in 1881 resulted in the Mississippi River abandoning a large loop around Kaskaskia Island (Illinois), so that the abandoned river channel (which remains the state boundary) forms a 16-mile-long wetland during most of the year. Virtually all Mississippi River elevations above flood stage are now maintained within high levees, but rare extreme events, such as the Great Flood of 1993, submerge the bottoms and effect major changes in the landscape. High discharges also modify channel geometry significantly. The river drops about 0.56 feet per mile between St. Louis and Cape Girardeau. Average discharge at St. Louis is 188,000 cubic feet per second and 206,000 cubic feet per second at Chester, Illinois. Discharge is partially regulated by the large dams mostly on the upper Mississippi and upper Missouri Rivers. Normally, discharge is highest during the months of May and June and lowest in winter. Icing may affect flow in midwinter. The Mississippi carries both a high bed load and a high suspended sediment load, most of it contributed by the Missouri River. Water quality is considered poor, since it receives the runoff of nearly 1 million square miles, including major metropolitan areas, but the enormous volume of the river tends to greatly dilute concentrations.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The dynamic system of braided and shifting channels created a mosaic of constantly shifting and renewing communities. Sandbars ranged from bare ground to thickets of willow and cottonwood seedlings. With time, they developed into riverfront forests of willow, cottonwood, elm, hackberry, and silver maple. Wet prairies occupied sandy soils, and marshes and shrub swamps occupied swales and abandoned channels. Mixed bottomland hardwood forests with oak, sugar maple, walnut, and bitternut hickory were limited to colluvial slopes and other higher surfaces infrequently flooded.

Current. Most of this subsection has been cleared and is in row crops. Only the lowest, wettest areas and those unprotected by levees have small, isolated patches of natural vegetation.

Major Natural Community Types

Riverine Sand Flats

Sycamore, Cottonwood–Black Willow Riverfront Forest

Southern Green Ash, Elm, Sugarberry Riverfront Forest

Pin Oak–Mixed Hardwood Wet Bottomland Forest

Oak, Sugar Maple, Bitternut Hickory Mesic Bottomland Forest

Rare or Restricted Natural Communities. All natural communities are rare today. Large sandbars and riverfront timber stands were relatively abundant but are rare today. The Mississippi River below the Missouri comprises its own unique big-rivers aquatic assemblage. The heritage database contains no records of natural communities within this subsection.

NATURAL DISTURBANCES

Flooding created a dynamic cycle of wetland destruction and creation that resulted in a remarkably diverse ecosystem. Drought and freezing helped to shape these systems.

RARE OR ENDANGERED SPECIES

The Mississippi River Alluvial Plain Subsection of the Ozark Highlands Section contains 63 records of 29 state-listed species. A large majority of these records are for fish species; the remainder are mainly wetland plants and birds. Three species of federal concern are the bald eagle *(Heliaeetus leucocephalus),* pallid sturgeon *(Scaphirhynchus albus),* and interior least tern *(Sterns antillarum* var. *athalassos).*

NATURAL AREAS

The small subsection has only one designated Natural Area, Tower Rock, which protects a large rock pedestal in the Mississippi River channel.

PUBLIC LANDS

The subsection has fewer than 500 acres of public land. Most of it is owned by the Missouri Department of Conservation.

HUMAN GEOGRAPHY

Demographics. Mississippi River bottomlands were used extensively by various

Jim Rathert

The interior least tern depends on sandbars for nesting habitat.

Indian groups for long periods of time in both the Ste. Genevieve and Bois Brule bottoms and at the mouth of the Missouri River. They also used the channel as a travel corridor, as French and Americans also did later. French began planting the Ste. Genevieve bottoms in the late 1740s. Americans settled the Bois Brule bottoms at the beginning of the nineteenth century. Farm population has never been very much in these bottoms, and it virtually disappeared after the Great Flood of 1993.

Economics and Land Use. Steamboating in the nineteenth century caused the bottomland timber to be cut for fuel. While few people live on the alluvial plain now, it is very extensively used for cropland, chiefly soybeans, wheat, and corn. Timber is along the river and in sloughs and former channels of the river.

LANDTYPE ASSOCIATIONS

The Mississippi River Alluvial Plain Subsection is subdivided into three landtype associations (LTAs), separated by narrow floodplains and varying somewhat in their character. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

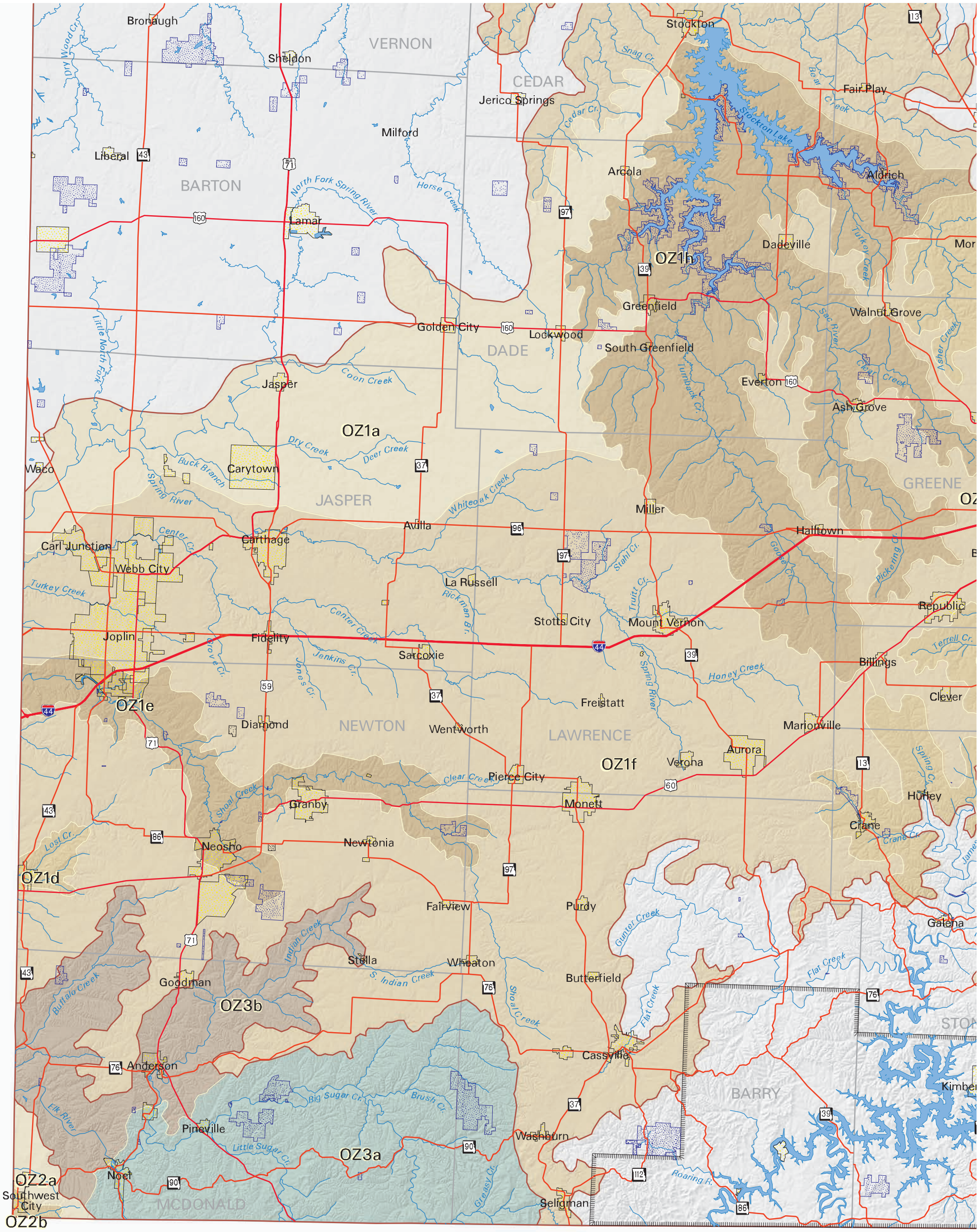
The Mississippi River Alluvial Plain, like most large alluvial plains in the state, has been severely altered by channelization, drainage, and conversion to agriculture. Natural hydrologic processes have been suppressed, and very little natural vegetation remains. Allowing for some conservation lands to act as flood storage during high water and emulating a more natural hydrograph in river management will promote native species and ecosystems. Finding ways for agriculture and native ecosystems to coexist in the alluvial plain and ways to reconcile multiple uses of the river channel will be key to future conservation success.

LANDTYPE ASSOCIATIONS IN THE MISSISSIPPI RIVER ALLUVIAL PLAIN SUBSECTION

(see landtype associations map pg. 176–177)

LANDTYPE ASSOCIATIONS IN THE MISSISSIPPI RIVER ALLUVIAL PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
OZ16a Ozarks-Mississippi River Alluvial Plain	This LTA occupies the channel and isolated, narrow portions of the alluvial plain from St. Louis City south to Scott County. The state line in the Mississippi River is the eastern boundary, and the abrupt bluff line is the western boundary. Northern and southern boundaries are at section-level breaks. The LTA excludes the two largest bottomland tracts, which constitute separate LTAs.	The small LTA consists of the channel of the Mississippi River and separate portions of its narrow alluvial plain within the Ozarks. It is mainly the river channel, which engineering works have greatly altered in the last century. The narrow alluvial plain fragments were formerly in riverfront timber and still are today, with small tracts of cropland.
OZ16b Big Field Alluvial Plain	The LTA occupies the Mississippi River bottoms at Ste. Genevieve. It is delimited by the river and the bluff line.	The very small LTA consists of the alluvial plain that has been in continuous cropland longer than any other tract of land in Missouri. Historically, it was mostly riverfront timber and prairie that was both natural and related to Native American activities. It is currently cropland.
OZ16c Bois Brule Alluvial Plain	The LTA is the largest alluvial plain on the Mississippi River within the Missouri Ozarks. It extends most of the length of Perry County. It is bounded by the Mississippi River and the bluff line.	The LTA occupies a large, continuous tract of alluvial plain, the Bois Brule Bottom, with highly variable soils. At the base of the bluff was a former linear lake and marsh, now drained and converted to crops. Elsewhere the surface was a series of swales and ridges with alternating wet and dry soils, prairie and timber, now also converted to crops. The Great Flood of 1993 altered the surface considerably. Several spring-fed Ozark creeks empty onto this bottomland.

for continuation see inset lower right



OZ1 - Springfield Plain Subsection

- OZ1a Lockwood Smooth Prairie Plain
- OZ1b Stockton Prairie/Savanna Dissected Plain
- OZ1c Weaubleau Prairie/Savanna Dissected Plain
- OZ1d Lost Creek Oak Savanna/Woodland Low Hills
- OZ1e Shoal Creek Oak Savanna/Woodland Low Hills
- OZ1f Spring River Prairie/Savanna Dissected Plain
- OZ1g Springfield Karst Prairie Plain
- OZ1h Upper Sac River Oak Savanna/Woodland Low Hills
- OZ1i Little Sac River Oak Savanna/Woodland Low Hills
- OZ1j James River Oak Savanna/Woodland Low Hills
- OZ1k Finley River Oak Savanna/Woodland Low Hills
- OZ1l Sparta Oak Savanna Plain
- OZ1m Seymour Highland Oak Savanna Dissected Karst Plain

map continued on pgs. 160–161 and 166–167

Landtype Associations

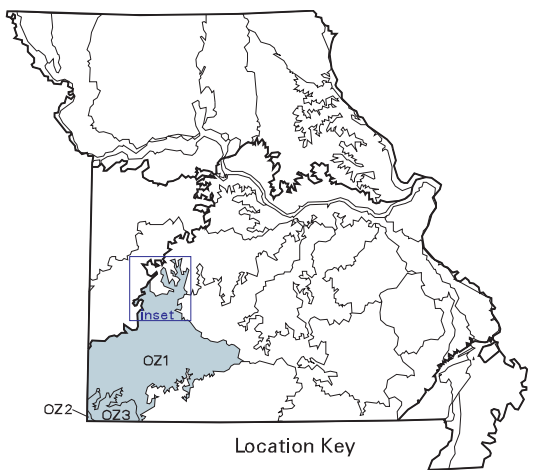
OZ1 Springfield Plain Subsection
See text on pg. 89

OZ2 Springfield Plateau Subsection
See text on pg. 95

OZ3 Elk River Hills Subsection
See text on pg. 95

First Approximation—March 2001

map continued on pgs. 158–161



Location Key

Public Lands- Federal

Public Lands - State

County Boundaries

Ecological Subsection Boundaries

Major Roads

US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi
0 10 20 30 km

map continued on pgs. 158–159

OZ2 - Springfield Plateau Subsection

OZ2a Southwest City Prairie Plain

OZ2b Southwest City Oak Savanna/Woodland Low Hills

OZ3 - Elk River Hills Subsection

OZ3a Big Sugar Creek Oak Woodland/Forest Hills

OZ3b Elk River Oak Woodland Dissected Plain

Landtype Associations

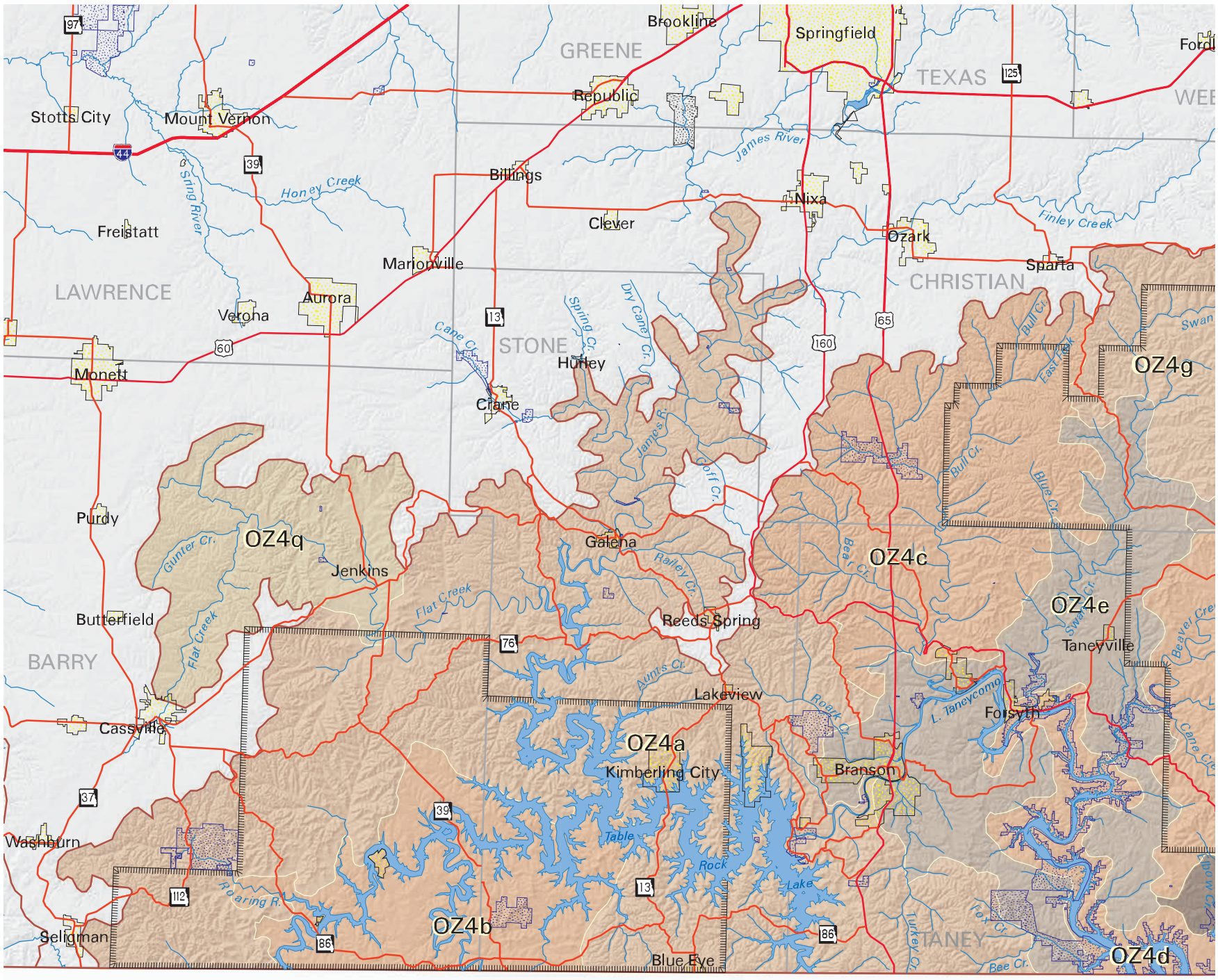
OZ4 White River Hills Subsection

See text on pg. 98

First Approximation—March 2001

Location Key

- OZ4a White River Dolomite Glade/Oak Woodland Rugged Hills and Knobs
- OZ4b Shell Knob Dolomite Glade/Oak Woodland Basin
- OZ4c Bull Creek Dolomite Glade/Oak Woodland Breaks
- OZ4d White River Dolomite Glade/Oak Woodland Breaks
- OZ4e Forsyth Oak Woodland Dissected Plain
- OZ4f Little North Fork Dolomite Glade/Oak Woodland Hills
- OZ4g Upper Swan Creek Dolomite Glade/Oak Forest Breaks
- OZ4h Gainesville Dolomite Glade/Oak Woodland Knobs
- OZ4i Hercules Dolomite Glade/Oak Woodland Knobs
- OZ4j Ava Oak Woodland Dissected Plain
- OZ4k Gainesville Oak Woodland Hills
- OZ4l Romance Oak Woodland Dissected Plain
- OZ4m Bryant Creek Oak-Pine Woodland/Forest Hills
- OZ4n Van Zant Oak Woodland Dissected Plain
- OZ4o North Fork River Oak-Pine Woodland/Forest Hills
- OZ4p North Fork Pine-Oak Woodland Dissected Plain
- OZ4q Jenkins Oak Savanna/Woodland Basin



Public Lands- Federal

Public Lands - State

County Boundaries

Ecological Subsection Boundaries

Major Roads

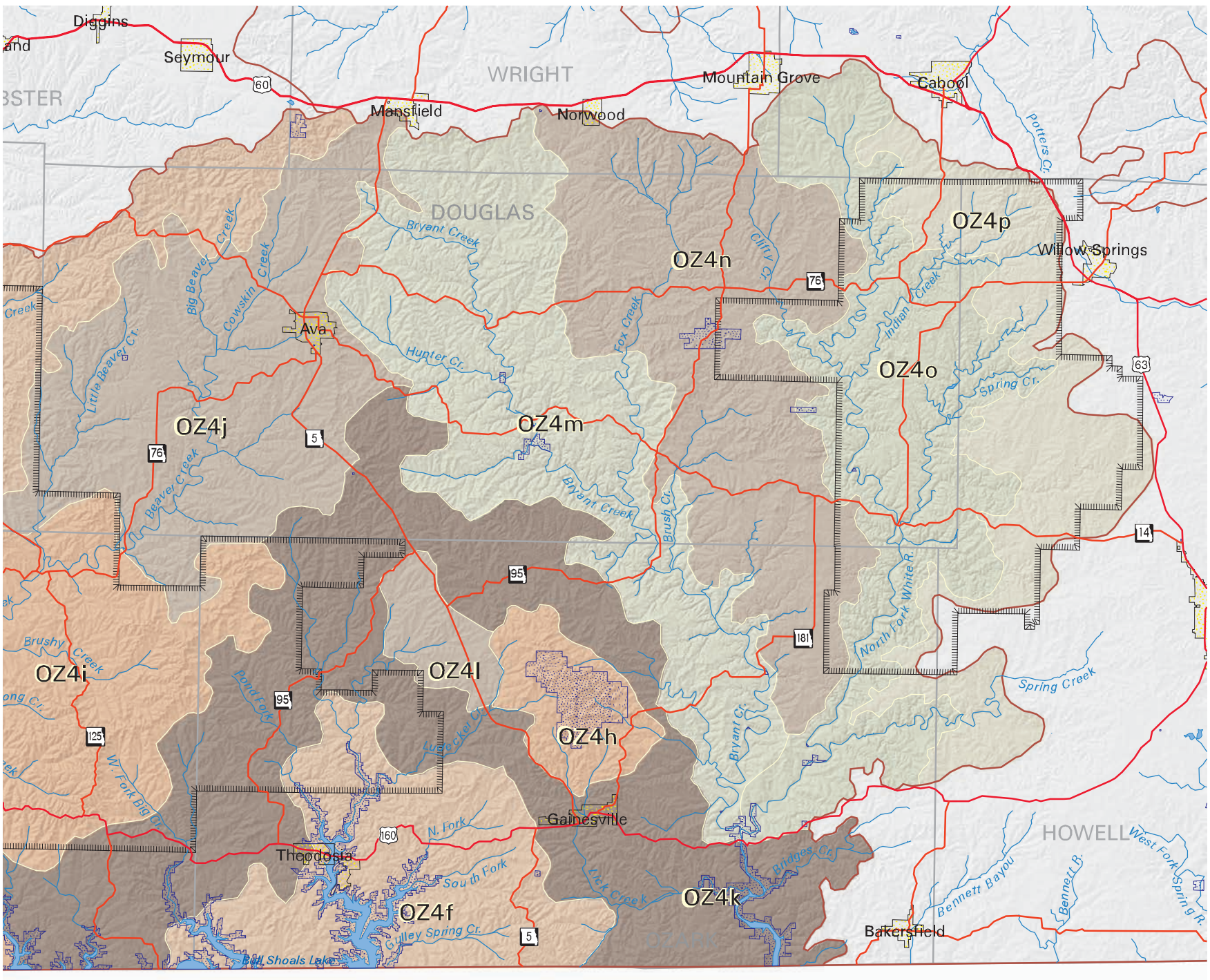
US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km

map continued on pgs. 156–157 and 160–161



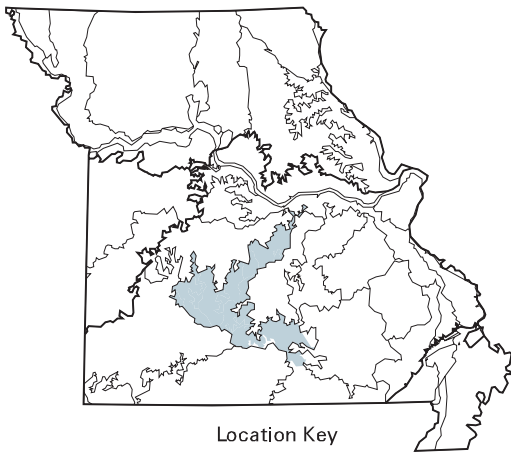
map continued on pgs. 160–161

Landtype Associations

OZ5 Central Plateau Subsection (western)

OZ5 (eastern) map on pgs. 162–163;
OZ5 (southern) map on pgs. 164–165;
see text on pg. 103

First Approximation—March 2001



Location Key

- OZ5a Bolivar Prairie/Savanna Plain
- OZ5b Upper Pomme de Terre Oak Savanna/Woodland Dissected Plain
- OZ5c Buffalo Prairie/Savanna Plain
- OZ5d Upper Niangua Oak Savanna/Woodland Dissected Plain
- OZ5e Upper Gasconade Oak Woodland Dissected Plain
- OZ5f Lebanon Prairie/Savanna Karst Plain
- OZ5g Auglaize Prairie/Savanna Dissected Plain
- OZ5h Tavern Creek Oak Savanna/Woodland Dissected Plain
- OZ5i Dixon Prairie/Savanna Dissected Plain
- OZ5j Linn Oak Woodland Dissected Plain
- OZ5k Upper Gasconade Oak Savanna/Woodland Plain

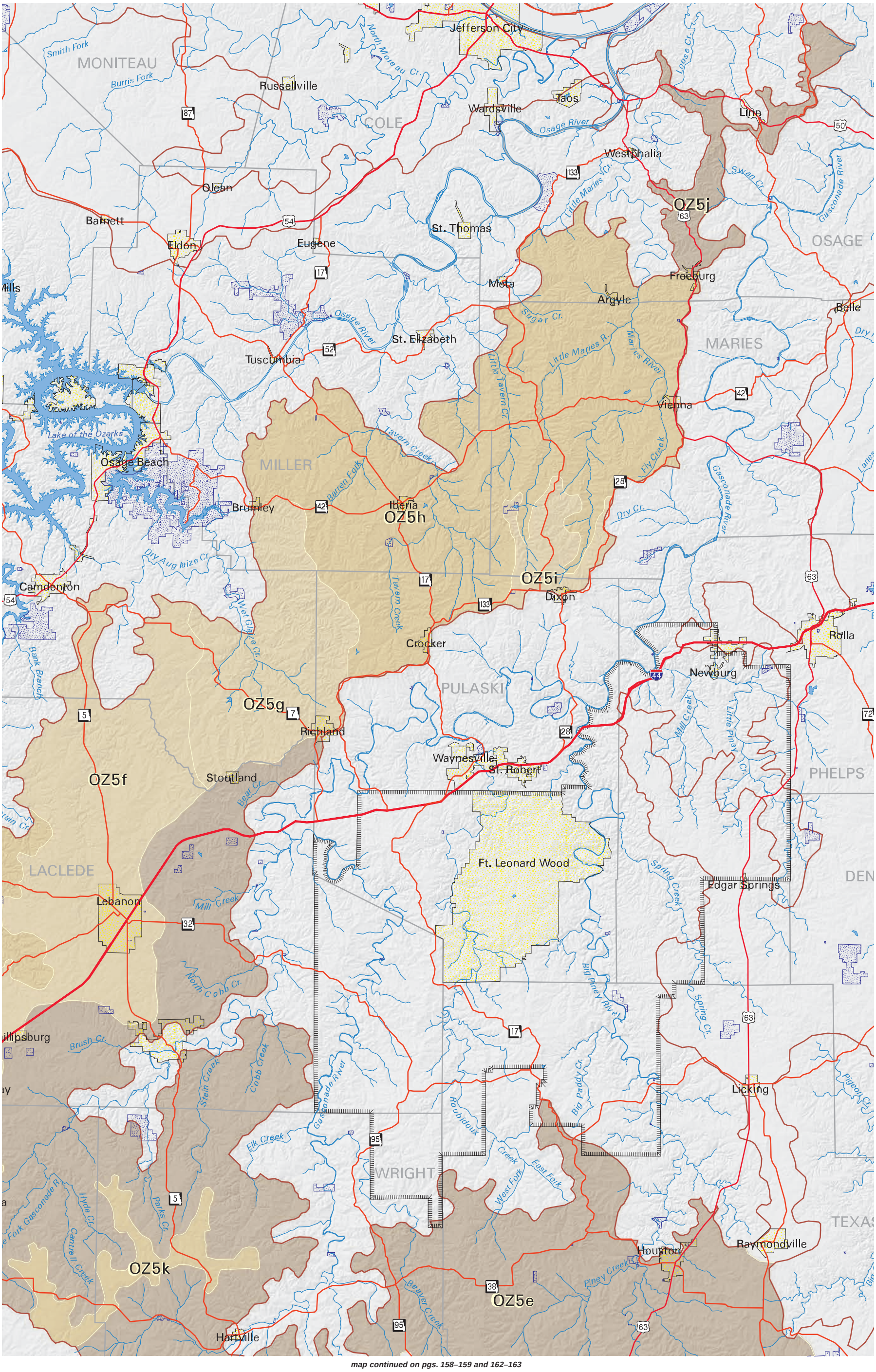
- Public Lands- Federal
- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi
0 10 20 30 km

map continued on pgs. 156–157 and 166–167

map continued on pgs. 166–167



map continued on pgs. 168–169

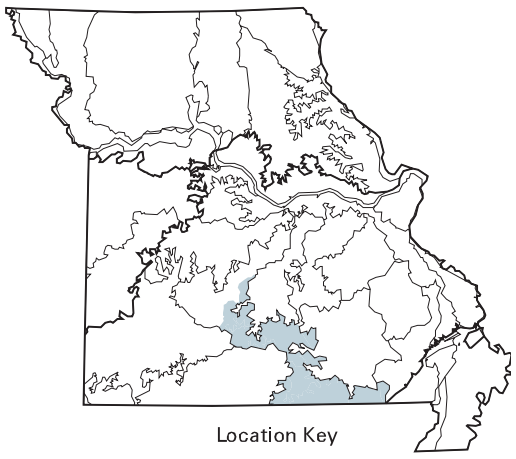
map continued on pgs. 158–159 and 162–163

Landtype Associations

OZ5 Central Plateau Subsection (southern)

OZ5 (western) on pgs. 160–161;
OZ5 (eastern) map on pgs. 162–163;
see text on pg. 103

First Approximation—March 2001



Location Key

map continued on pgs. 158–161

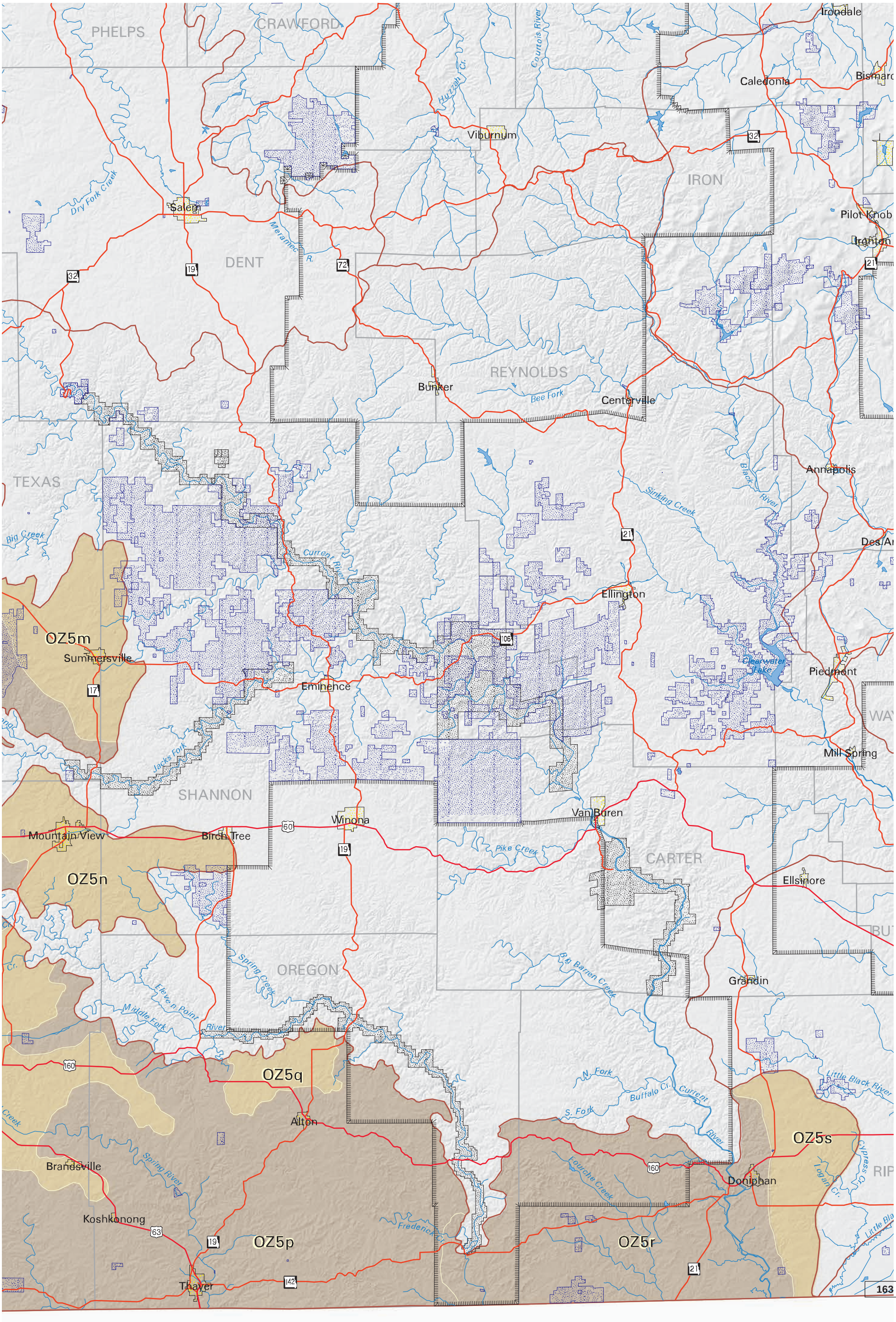
- OZ5e Upper Gasconade Oak Woodland Dissected Plain
- OZ5k Upper Gasconade Oak Savanna/Woodland Plain
- OZ5l Cabool-Mountain Grove Oak Savanna/Woodland Plain
- OZ5m Summersville Oak Savanna/Woodland Plain
- OZ5n Mountain View Oak Savanna/Woodland Plain
- OZ5o West Plains Oak Savanna/Woodland Plain
- OZ5p Howell-Oregon Counties Oak Woodland Dissected Plain
- OZ5q Alton Oak Savanna/Woodland Plain
- OZ5r Ripley County Oak Woodland Dissected Plain
- OZ5s Flatwoods Oak Savanna/Woodland Plain

- Public Lands- Federal
- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi
0 10 20 30 km

map continued on pgs. 168–169 and 172–173



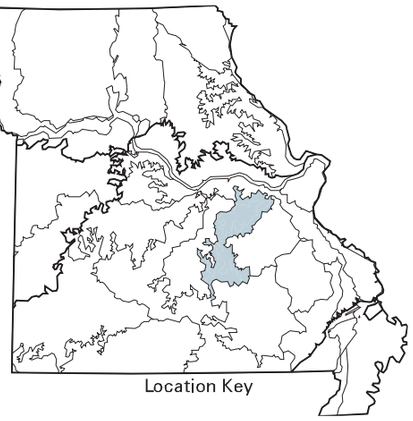
map continued on pgs. 172–173

Landtype Associations

OZ5 Central Plateau Subsection (eastern)

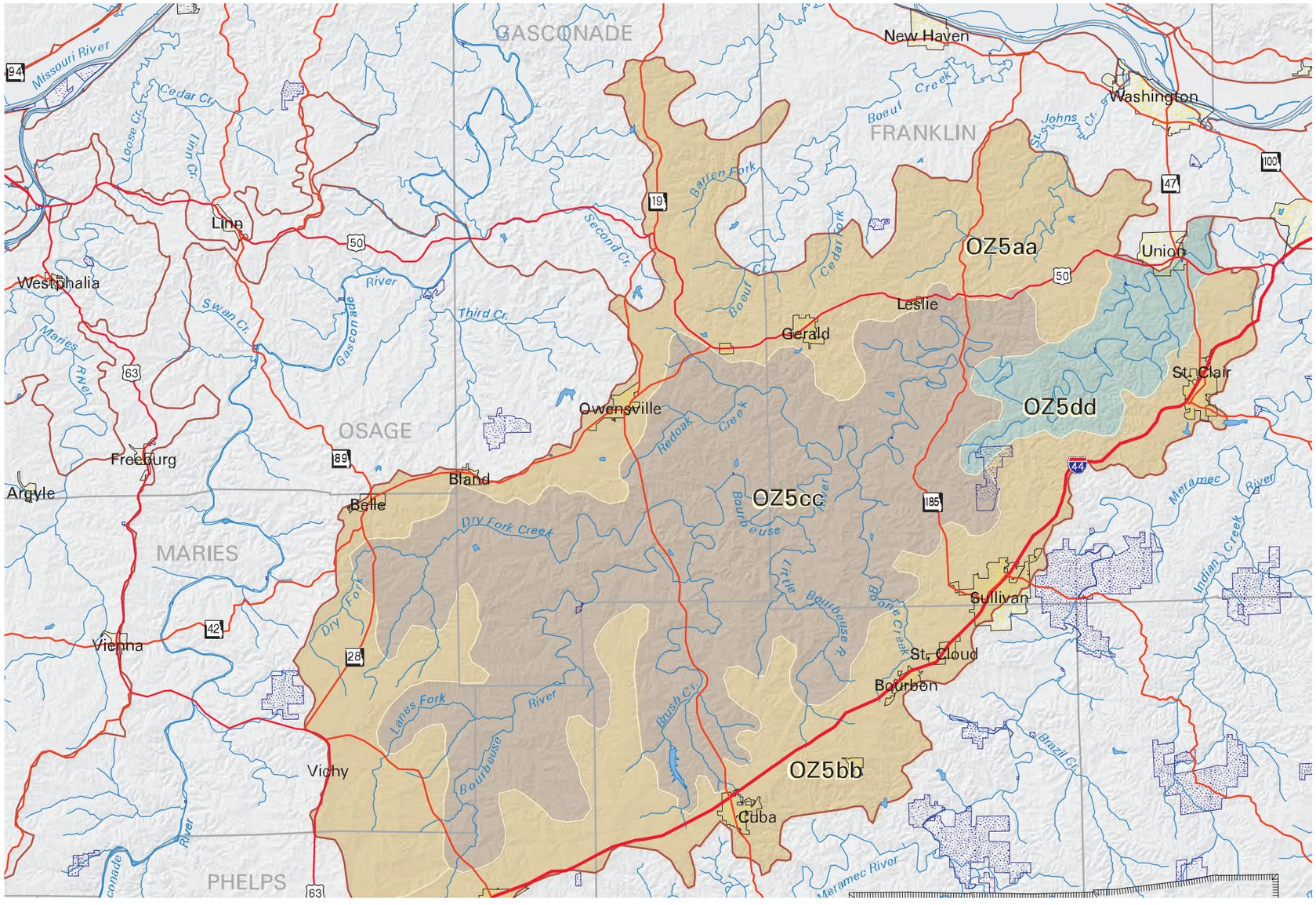
OZ5 (western) map on pgs. 160–161; OZ5 (southern map on pgs. 164–165; see text on pg. 103

First Approximation—March 2001



- OZ5t Licking Oak Savanna/Woodland Plain
- OZ5u Big Piney Oak Woodland Dissected Plain
- OZ5v Little Piney Oak Woodland Dissected Plain
- OZ5w Salem Oak Savanna/Woodland Plain
- OZ5x Upper Meramec Oak Woodland Dissected Plain
- OZ5y Dry Fork Oak Woodland Dissected Plain
- OZ5z Rolla Oak Savanna/Woodland Plain
- OZ5aa Gasconade-Bourbeuse Oak Savanna/Woodland Plain
- OZ5bb Bourbeuse-Meramec Oak Savanna/Woodland Plain
- OZ5cc Bourbeuse River Oak Woodland Dissected Plain
- OZ5dd Bourbeuse River Oak Woodland Hills

map continued on pgs. 168–169 and 174–175



Public Lands- Federal

Public Lands - State

County Boundaries

Ecological Subsection Boundaries

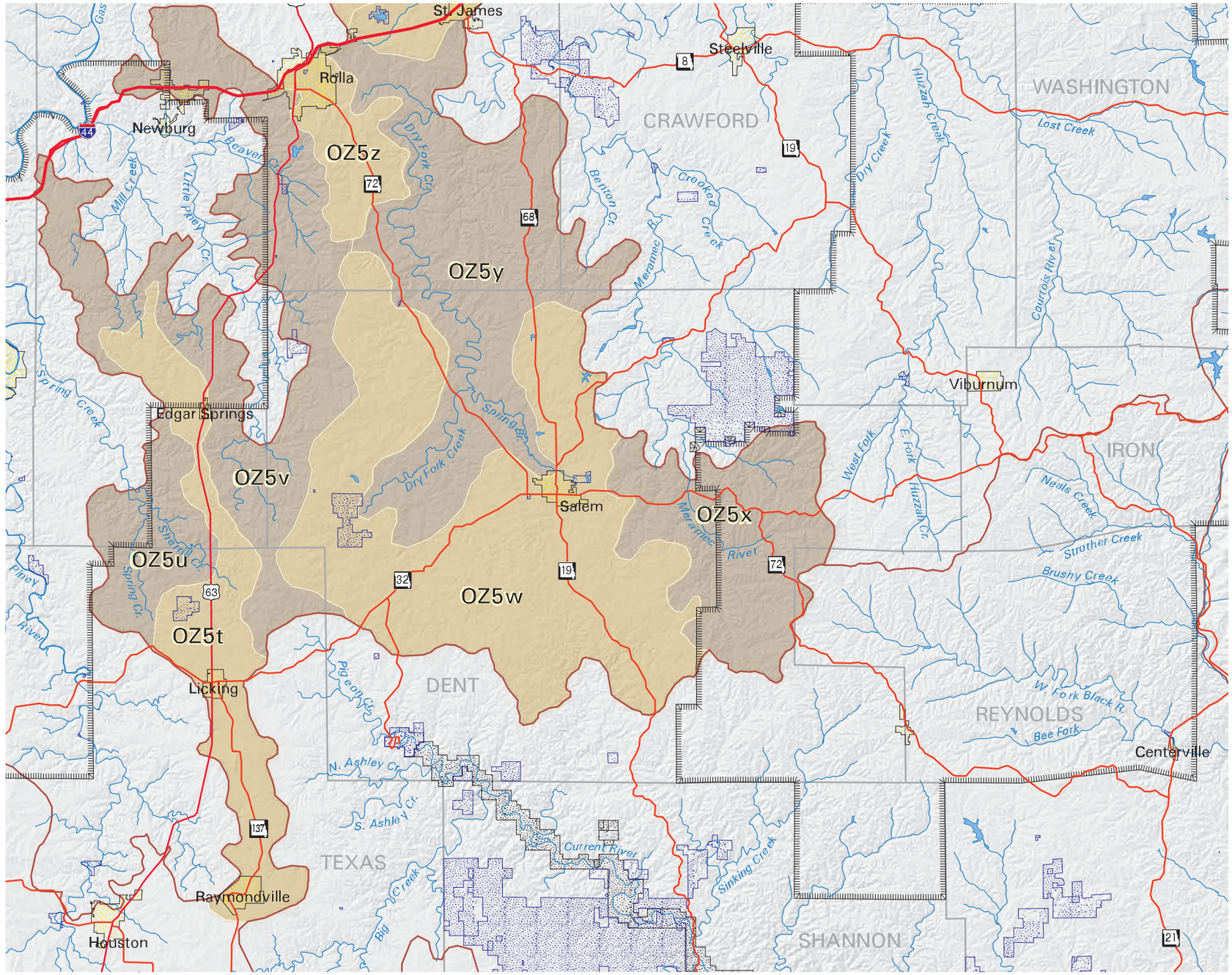
Major Roads

US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km



map continued on pgs. 168–169

map continued on pgs. 170–171

map continued on pgs. 172–173

Landtype Associations

OZ6 Osage River Hills Subsection

See text on pg. 110

First Approximation—March 2001

Location Key

map continued on pgs. 84–85 and 174–175

map continued on pgs. 84–85

map continued on pgs. 160–161

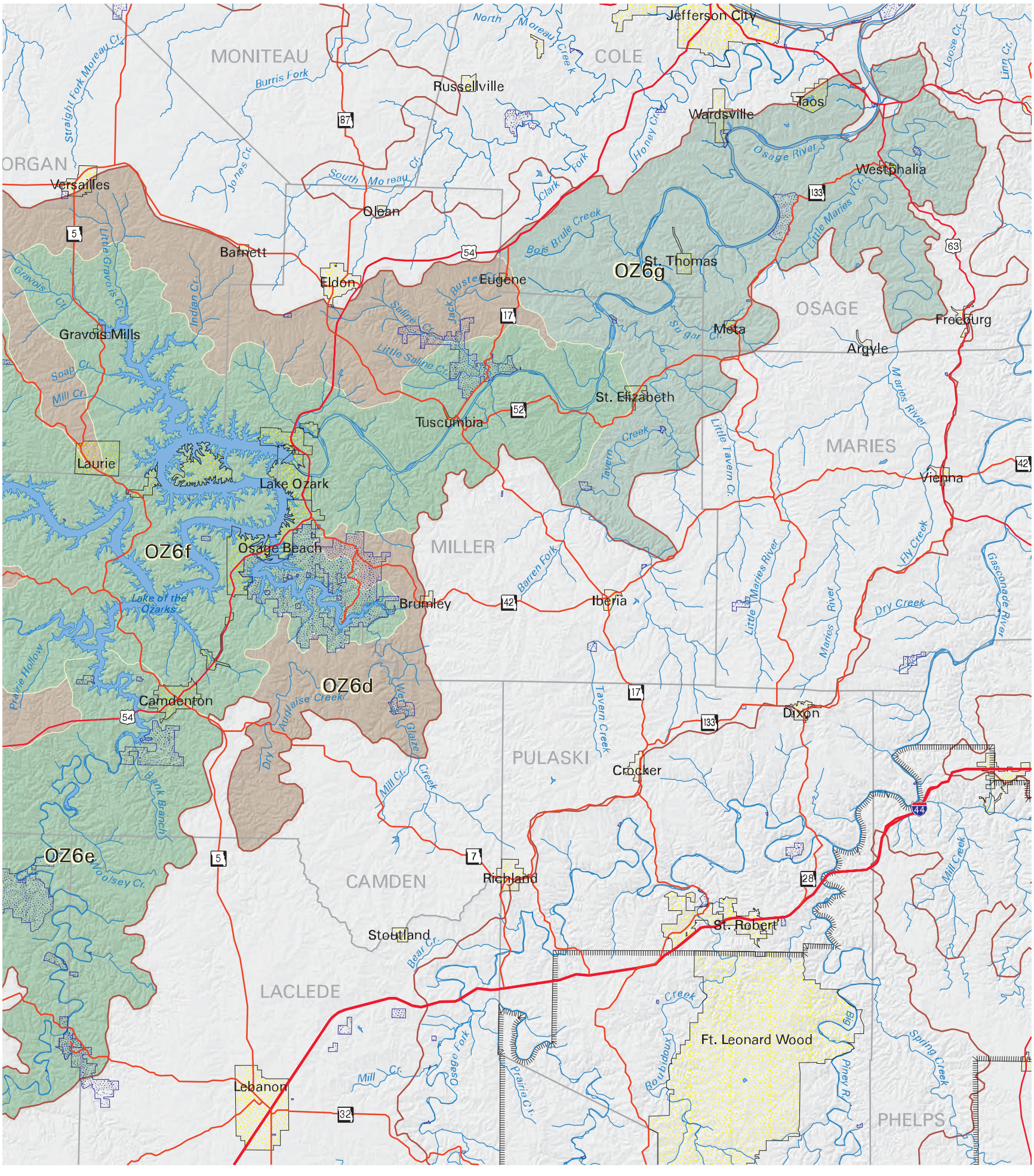
- OZ6a Lower Sac River Oak Woodland Hills
- OZ6b Truman Lake Oak Woodland Hills
- OZ6c Pomme de Terre Dolomite Glade/Woodland Hills
- OZ6d Middle Osage River Oak Woodland Hills
- OZ6e Niangua River Oak Woodland/Forest Breaks
- OZ6f Lake Ozark Oak Woodland/Forest Breaks
- OZ6g Lower Osage River Oak Woodland/Forest Hills

- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km



map continued on pgs. 160–161

Landtype Associations

OZ7 Gasconade River Hills Subsection

See text on pg. 115

First Approximation—March 2001

Location Key

- OZ7a Upper Gasconade Oak Woodland Hills
- OZ7b Upper Gasconade Hills Oak Woodland Dissected Plain
- OZ7c Roubidoux Creek Oak Woodland/Forest Hills
- OZ7d Big Piney Hills Oak Woodland Dissected Plain
- OZ7e Big Piney River Oak-Pine Woodland/Forest Hills
- OZ7f Fort Leonard Wood Oak Savanna/Woodland Plain
- OZ7g Middle Gasconade River Oak Woodland/Forest Breaks
- OZ7h Middle Gasconade River Oak Woodland Benchland
- OZ7i Little Piney River Oak-Pine Woodland/Forest Hills
- OZ7j Big Piney Pine-Oak Woodland Dissected Plain
- OZ7k Lower Gasconade River Oak Woodland/Forest Hills

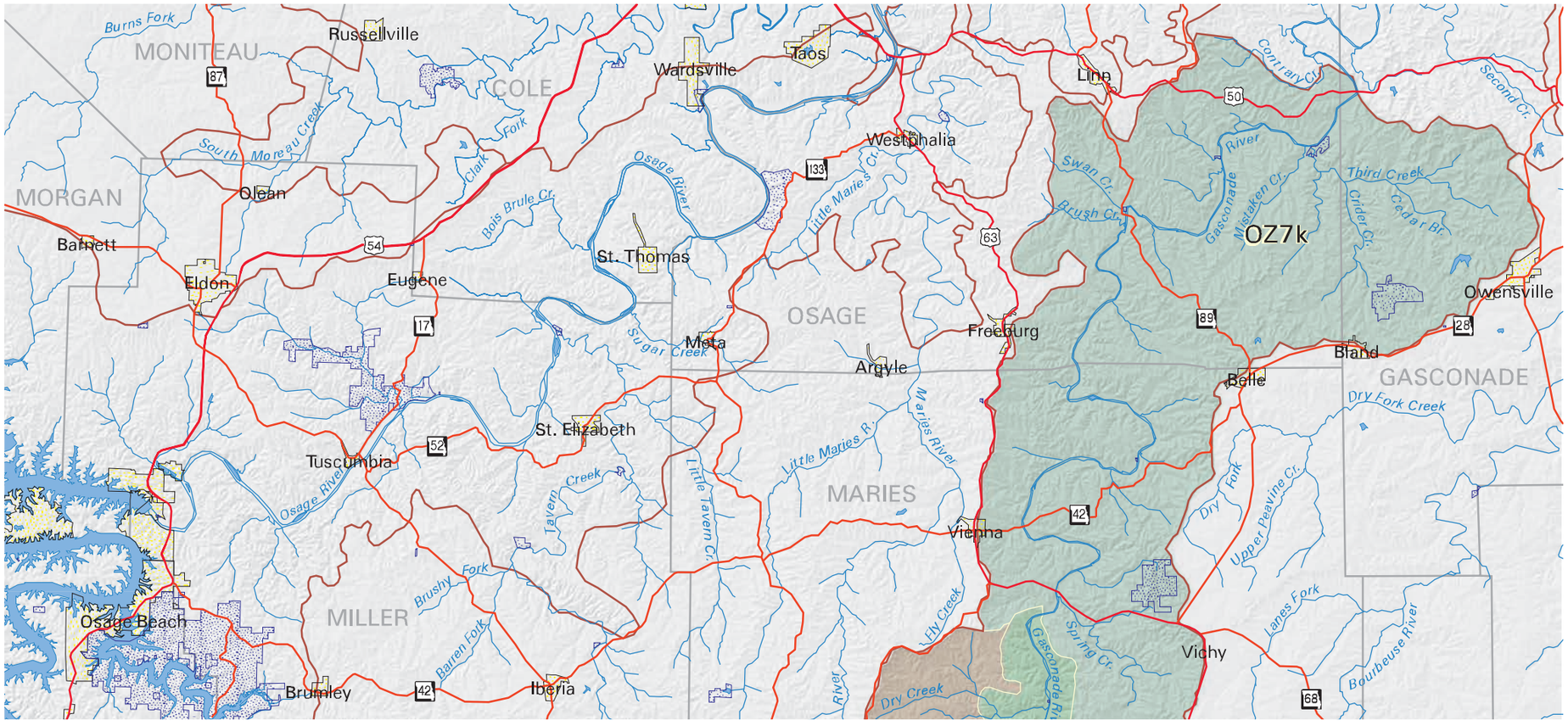
- Public Lands- Federal
- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

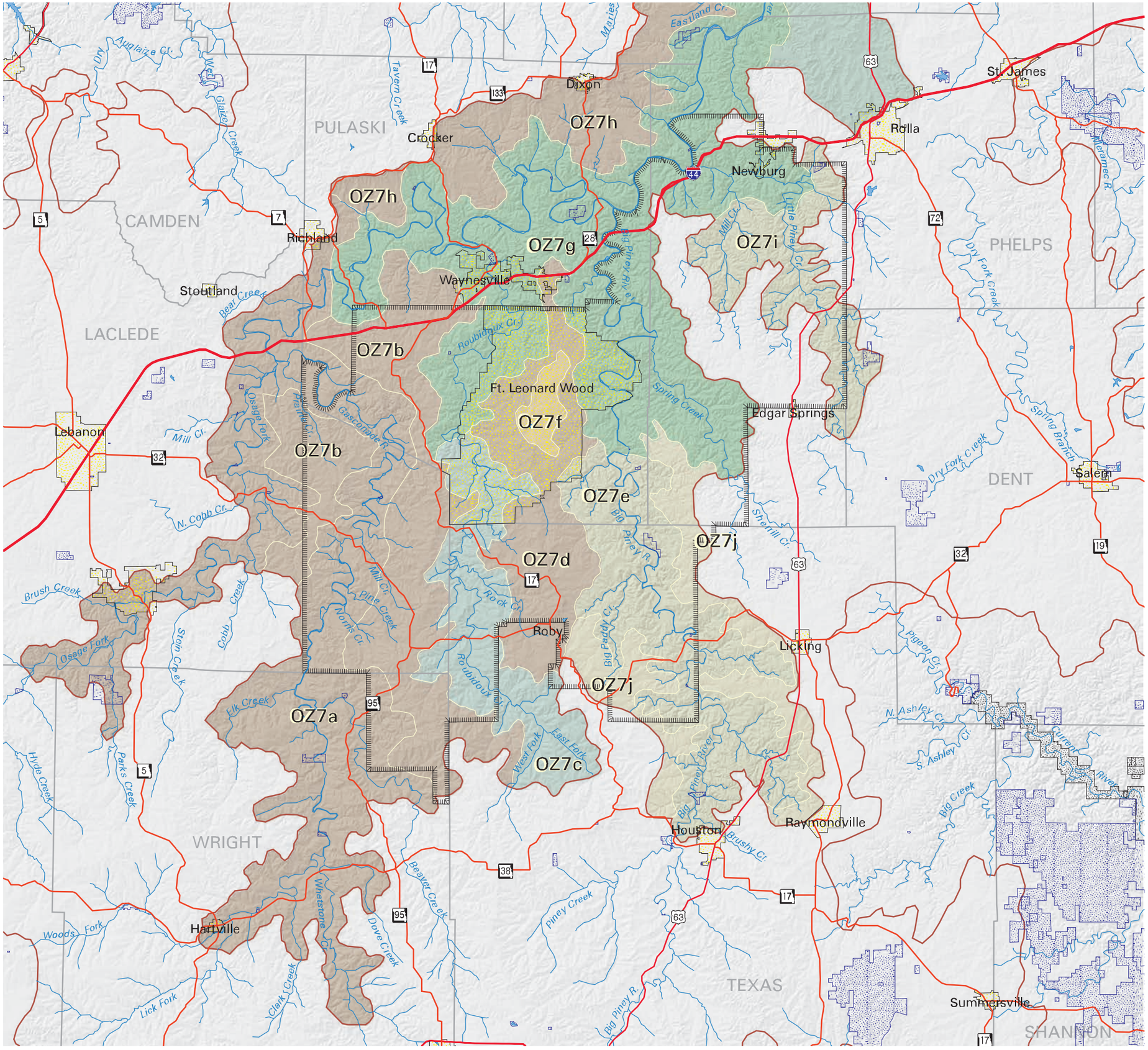
Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km

map continued on pgs. 160–161 and 174–175





map continued on pgs. 160–161

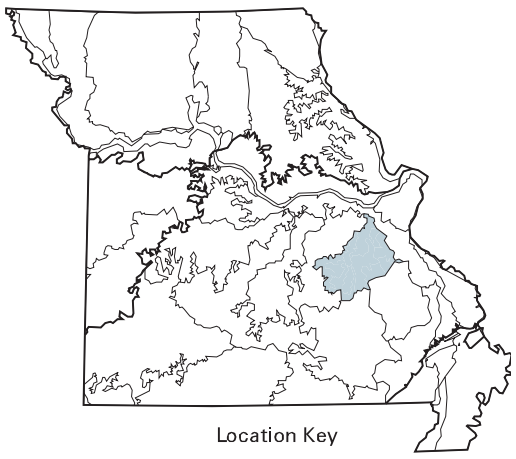
map continued on pgs. 164–165

Landtype Associations

OZ8 Meramec River Hills Subsection

See text on pg. 120

First Approximation—March 2001



Location Key

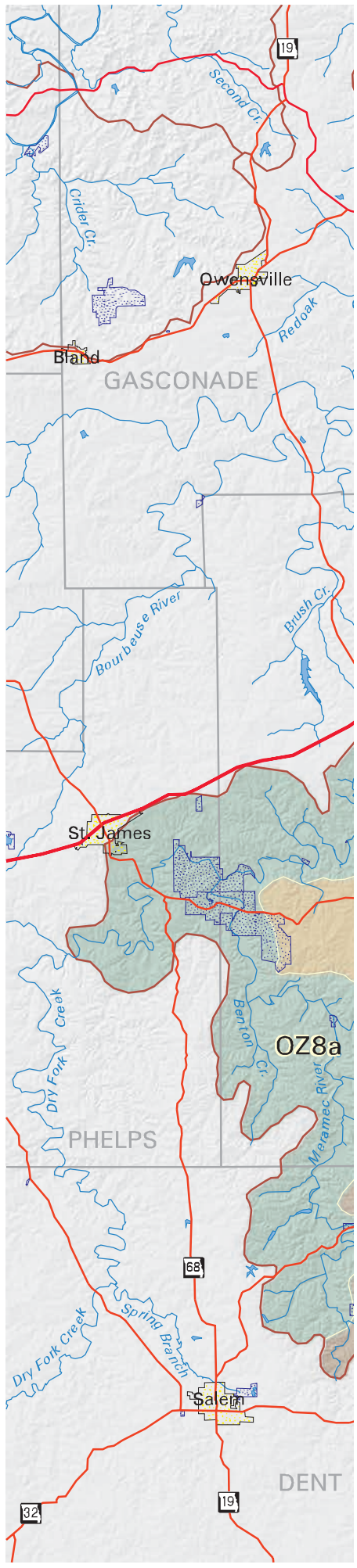
- OZ8a West Meramec River Oak Woodland/Forest Hills
- OZ8b Cherryville Oak Savanna/Woodland Plain
- OZ8c Huzzah-Courtois Oak Woodland Dissected Plain
- OZ8d Meramec River Oak Forest Breaks
- OZ8e Huzzah Oak Woodland/Forest Hills
- OZ8f Courtois Oak-Pine Woodland/Forest Hills
- OZ8g East Meramec Oak Woodland/Forest Hills
- OZ8h Indian Prairie Oak Savanna/Woodland Plain
- OZ8i Big River Oak Woodland/Forest Hills
- OZ8j Clear Creek Pine-Oak Woodland Dissected Plain
- OZ8k Potosi Oak Savanna/Woodland Plain

- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

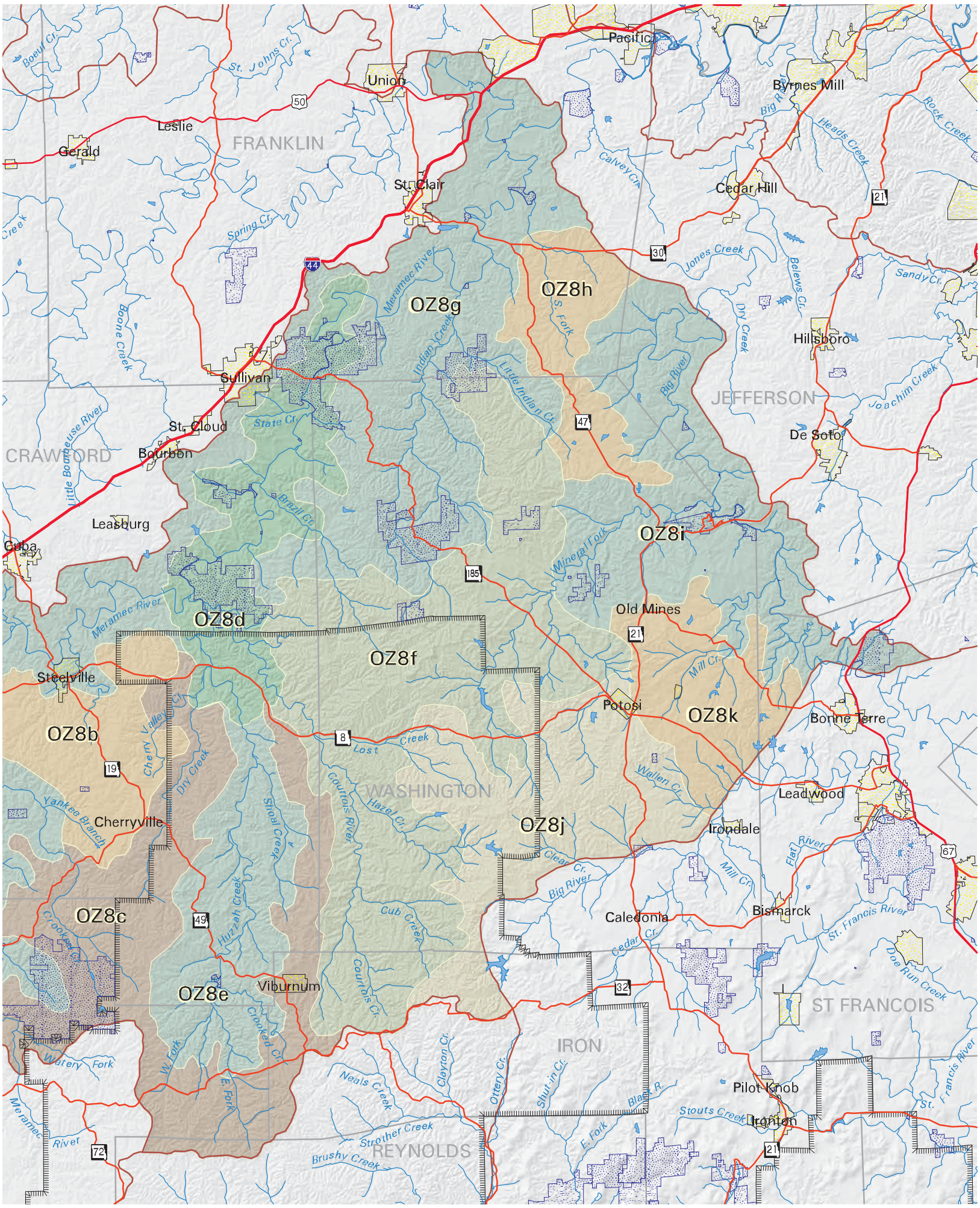
0 5 10 15 20 mi

0 10 20 30 km



map continued on pgs. 164–165

map continued on pgs. 164–165



map continued on pgs. 176–177 and 180

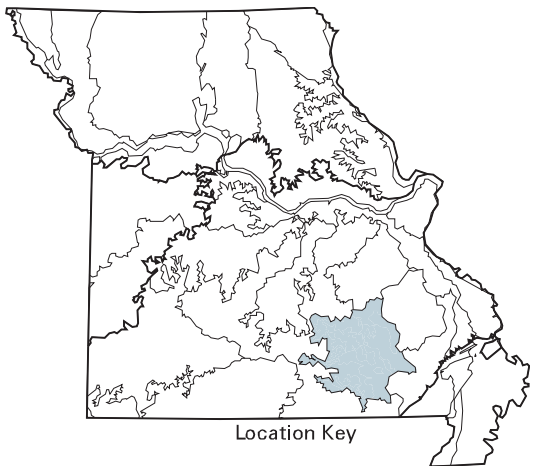
map continued on pgs. 172–173 and 180

Landtype Associations

OZ9 Current River Hills Subsection

See text on pg. 125

First Approximation—March 2001



- OZ9a Current River Pine-Oak Woodland Dissected Plain
- OZ9b Current River Oak-Pine Woodland/Forest Hills
- OZ9c Eleven Point River Oak-Pine Woodland/Forest Hills
- OZ9d Black River Oak-Pine Woodland/Forest Hills
- OZ9e Current River Oak Forest Breaks
- OZ9f Jacks Fork River Oak-Pine Forest Breaks
- OZ9g Eleven Point Oak-Pine Forest Breaks
- OZ9h Black River Oak Forest Breaks
- OZ9i Eminence Igneous Glade/Oak Forest Knobs

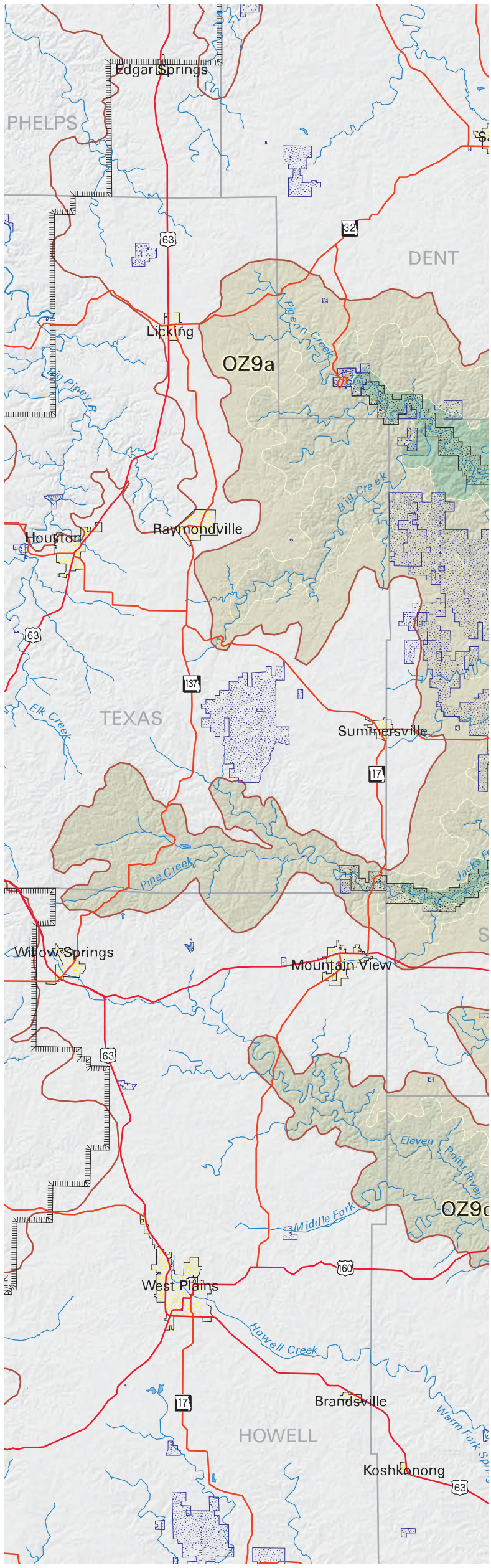
- Public Lands- Federal
- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

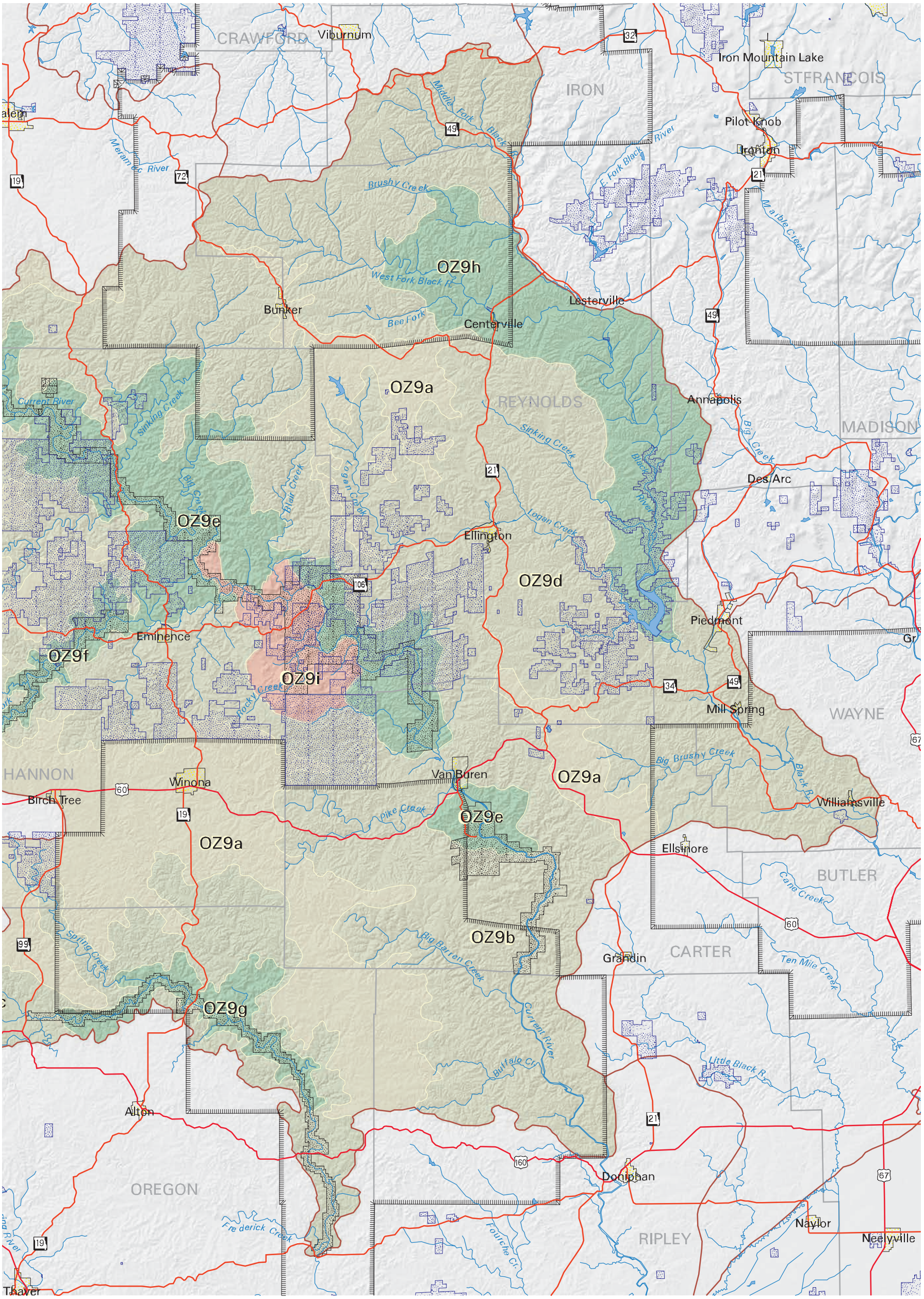
0 5 10 15 20 mi

0 10 20 30 km

map continued on pgs. 162–163



map continued on pgs. 164–165 and 170–171



map continued on pgs. 178–180

map continued on pgs. 162–163

Landtype Associations

*[**Note:** OZ10 St. Francois Knobs and Basins Subsection map appears on pg. 180]*

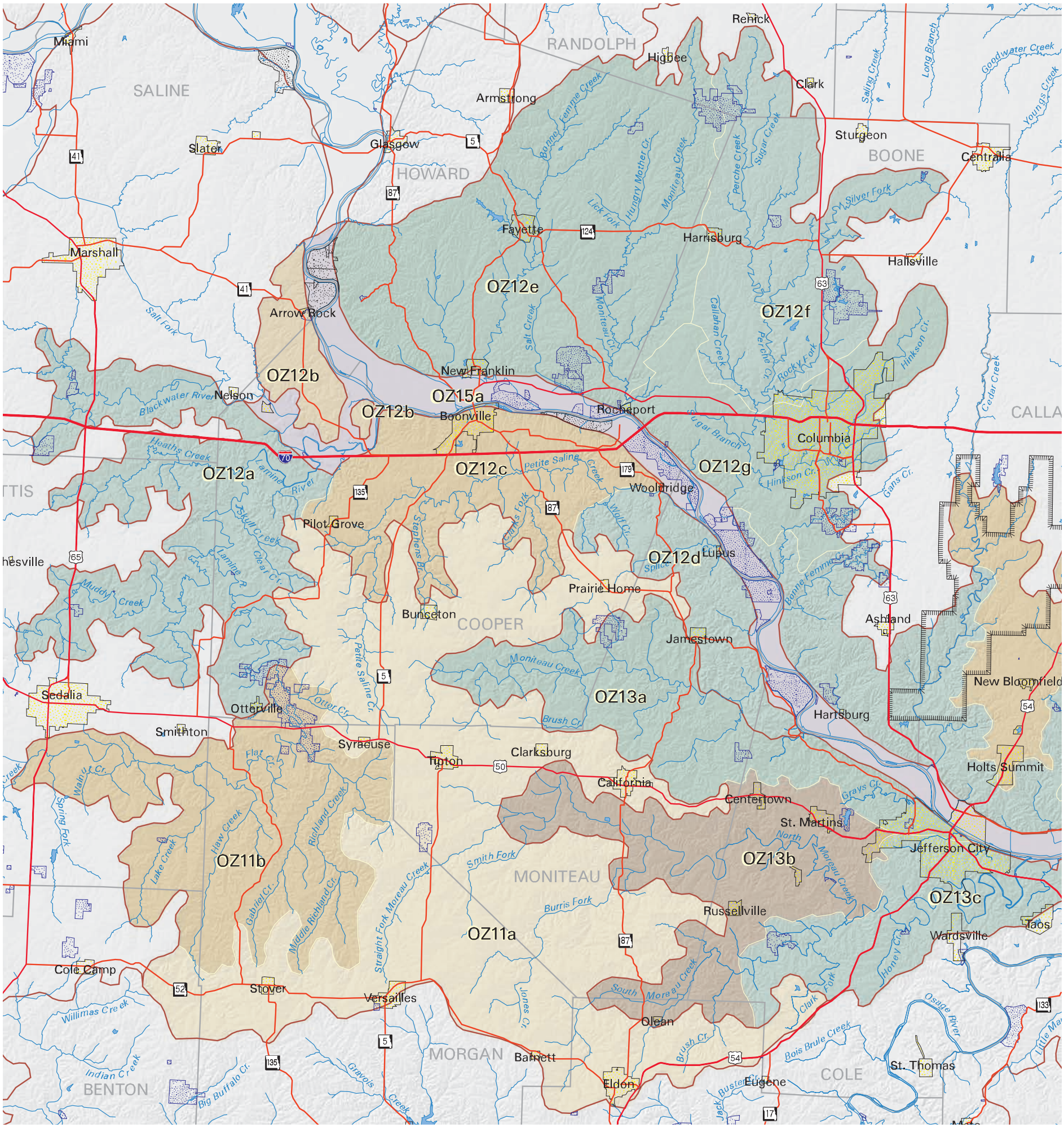
OZ11 Prairie Ozark Border Subsection
See text on pg. 132

OZ12 Outer Ozark Border Subsection (western)
OZ12 (eastern) map on pgs. 176–177; see text on pg. 134

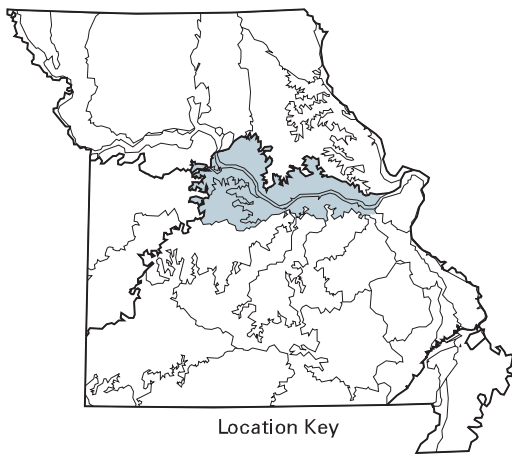
OZ13 Inner Ozark Border Subsection (western)
OZ13 (eastern) map on pgs. 176–177; see text on pg. 143

OZ15 Missouri River Alluvial Plain Subsection (western)
OZ15 (eastern) map on pgs. 176–177; see text on pg. 151

First Approximation—March 2001



map continued on pgs. 60–61 and 82–83



Public Lands- Federal

Public Lands - State

County Boundaries

Ecological Subsection Boundaries

Major Roads

US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km

map continued on pgs. 66–67

OZ11 - Prairie Ozark Border Subsection

OZ11a Tipton Upland Prairie Plain

OZ11b Upper Lamine Savanna/Woodland Dissected Plain

OZ12 - Outer Ozark Border Subsection

OZ12a Lower Lamine River Woodland/Forest Hills

OZ12b Arrow Rock Prairie/Woodland Dissected Karst Plain

OZ12c Petite Saline Savanna/Woodland Dissected Plain

OZ12d Jamestown Oak Woodland/Forest Karst Hills

OZ12e Boonslick Oak Woodland/Forest Hills

OZ12f Harrisburg Oak Woodland/Forest Hills

OZ12g Rockbridge Oak Woodland/Forest Low Karst Hills

OZ12h Central Missouri Oak Woodland/Forest Hills

OZ12i Montgomery-Warren Oak Woodland/Forest Rugged Hills

OZ12j Mokane Mixed-Hardwood Woodland/Forest Low Strath Hills

OZ12k Holstein Mixed-Hardwood Woodland/Forest Low Strath Hills

OZ12l Loutre River Alluvial Plain

OZ12m Central Missouri Savanna/Woodland Dissected Plain

OZ13 - Inner Ozark Border Subsection

OZ13a Moniteau Creek Woodland/Forest Hills

OZ13b Upper Moreau River Oak Woodland Dissected Plain

OZ13c South Fork Moreau River Woodland/Forest Hills

OZ13d Osage-Gasconade River Oak Woodland/Forest Hills

OZ13e Osage County Loess Woodland/Forest Hills

OZ13f Hermann Oak Woodland/Forest Rugged Hills

OZ13g Lower Osage River Alluvial Plain

OZ13h Lower Gasconade River Alluvial Plain

OZ13i Franklin County Oak Woodland/Forest Low Hills

OZ15 - Missouri River Alluvial Plain Subsection

OZ15a Lower Missouri River Alluvial Plain

map continued on pgs. 176–177

map continued on pgs. 164–169

map continued on pgs. 68–69

map continued on pgs. 164–165, 170–171 and 180

Landtype Associations

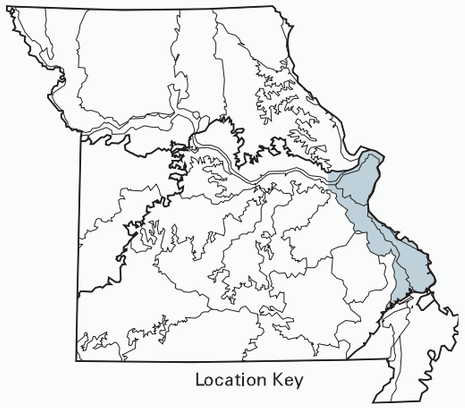
OZ12 Outer Ozark Border Subsection (eastern)
OZ12 (western) map on pgs. 174–175; see text on pg. 134

OZ13 Inner Ozark Border Subsection (eastern)
OZ13 (western) map on pgs. 174–175; see text on pg. 143

OZ15 Missouri River Alluvial Plain Subsection (eastern)
OZ15 (western) map on pgs. 174–175; see text on pg. 151

OZ16 Mississippi River Alluvial Plain Subsection
See text on pg. 154

First Approximation—March 2001



Public Lands- Federal

Public Lands - State

County Boundaries

Ecological Subsection Boundaries

Major Roads

US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km

OZ12 - Outer Ozark Border Subsection

- OZ12i Montgomery-Warren Oak Woodland/Forest Rugged Hills
- OZ12n Wildwood Loess Woodland/Forest Breaks
- OZ12o Chesterfield Oak Savanna/Woodland Dissected Plain
- OZ12p St. Louis County Prairie/Savanna Dissected Karst Plain
- OZ12q Florissant Karst Prairie Plain
- OZ12r St. Louis Karst Prairie Plain
- OZ12s Lower Meramec Hills Alluvial Plain
- OZ12t Lower Meramec Oak and Mixed-Hardwood Woodland/Forest Hills
- OZ12u Lower Meramec Highlands Alluvial Plain
- OZ12v Meramec Highlands Oak Woodland/Forest Rugged Hills
- OZ12w St. Mary Oak and Mixed-Hardwood Forest Hills
- OZ12x Brickey Limestone Glade/Mixed-Hardwood Forest Rugged Hills
- OZ12y Zell Platform Woodland/Forest Low Hills
- OZ12z Cape Oak and Mixed-Hardwood Forest Hills
- OZ12aa Perry Oak Savanna/Woodland Dissected Plain
- OZ12bb Benton Loess Woodland/Forest Hills
- OZ12cc Benton Hills Alluvial Plains and Footslopes

OZ13 - Inner Ozark Border Subsection

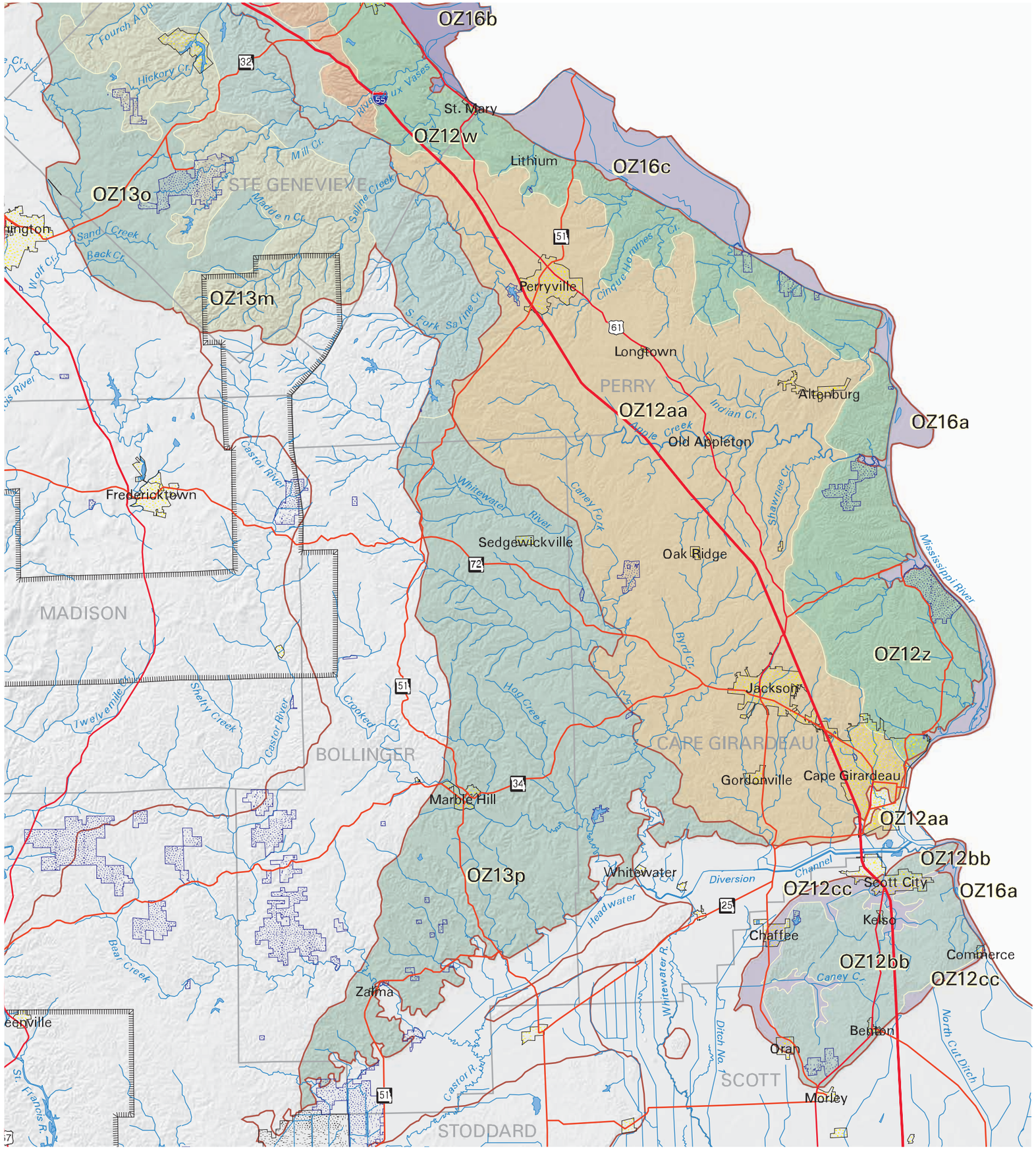
- OZ13i Franklin County Oak Woodland/Forest Low Hills
- OZ13j Pacific Alluvial Plain
- OZ13k Big River Dolomite Glade/Oak Woodland Low Hills
- OZ13l Big River Alluvial Plain
- OZ13m Rocky Ridge Oak and Oak-Pine Woodland/Forest Hills
- OZ13n Kinsey Oak Woodland/Forest Hills
- OZ13o Lamotte Sandstone Oak Woodland/Forest Basin
- OZ13p East Bollinger Oak Woodland/Forest Hills

OZ15 - Missouri River Alluvial Plain Subsection

- OZ15a Lower Missouri River Alluvial Plain
- OZ15b Marais Temps Clair Alluvial Plain
- OZ15c West Alton Alluvial Plain

OZ16 - Mississippi River Alluvial Plain Subsection

- OZ16a Ozarks-Mississippi River Alluvial Plain
- OZ16b Big Field Alluvial Plain
- OZ16c Bois Brule Alluvial Plain



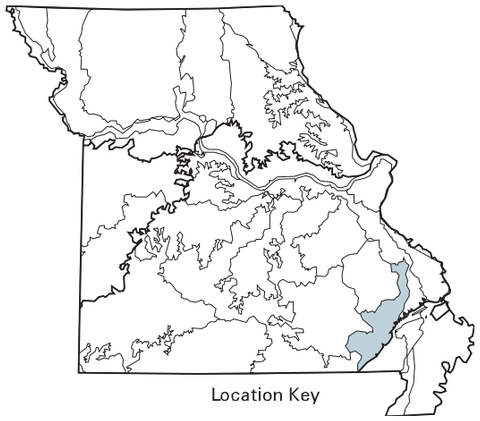
map continued on pgs. 196–197

Landtype Associations

OZ14 Black River Ozark Border Subsection

See text on pg. 148

First Approximation—March 2001



Location Key

OZ14a Grandin Pine-Oak Woodland Dissected Plain

OZ14b Southeastern Oak Savanna/Woodland Plain

OZ14c Wappappello Oak-Pine Woodland/Forest Hills

OZ14d West Bollinger Oak-Pine Woodland/Forest Hills

Public Lands- Federal

Public Lands - State

County Boundaries

Ecological Subsection Boundaries

Major Roads

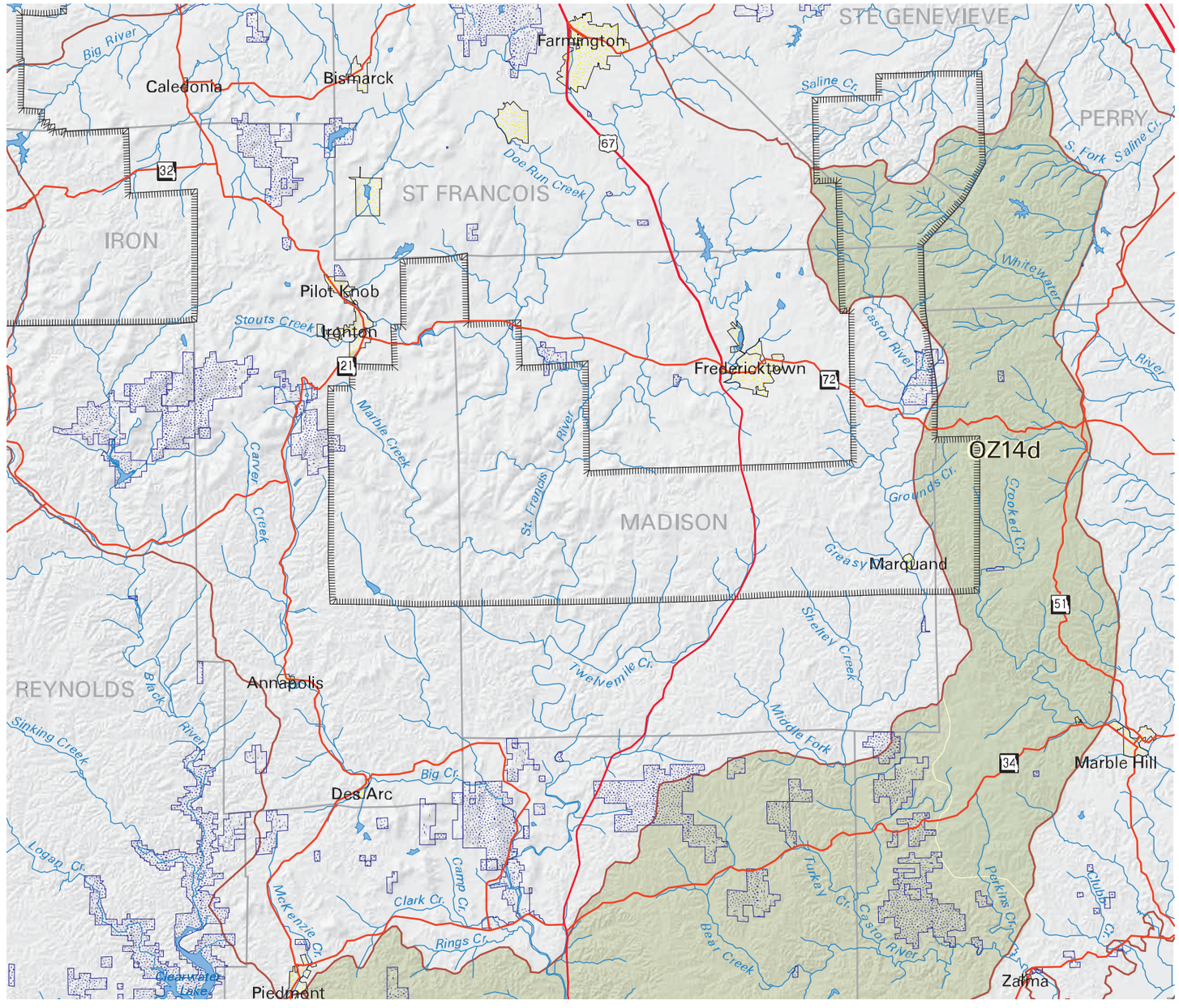
US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

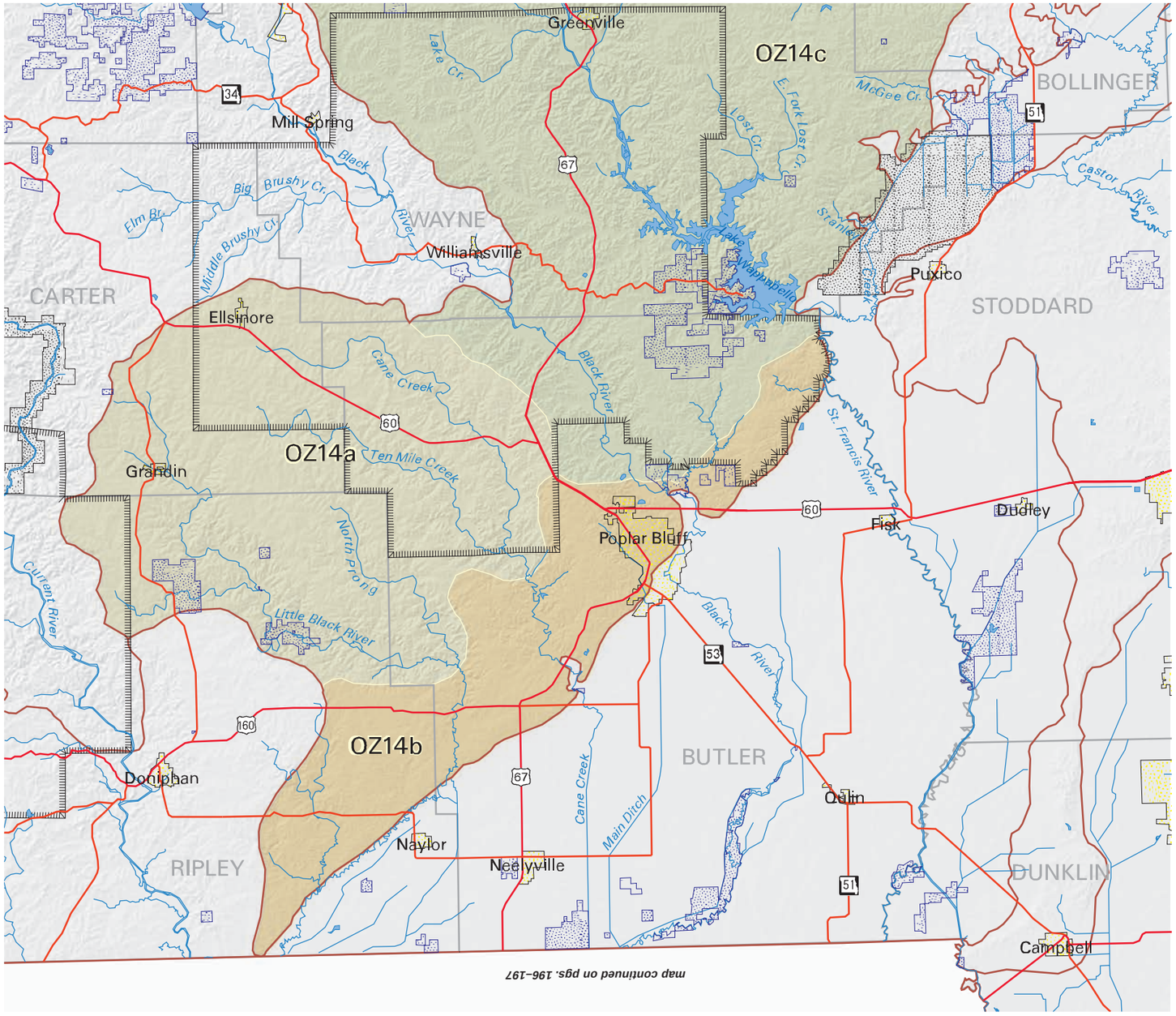
0 5 10 15 20 mi

0 10 20 30 km

map continued on pgs. 176–177 and 180



map continued on pgs. 172–173



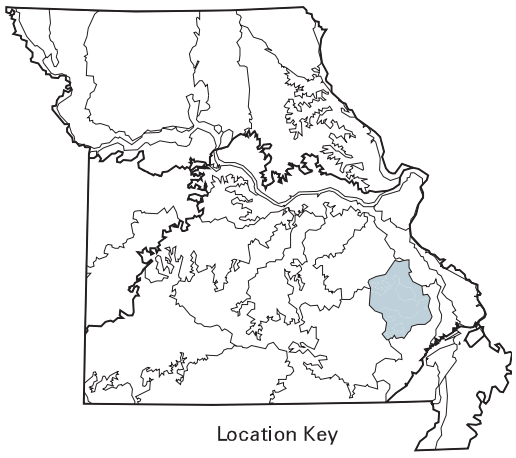
map continued on pgs. 196–197

Landtype Associations

OZ10 St. Francois Knobs and Basins Subsection

See text on pg. 129

First Approximation—March 2001



Location Key

OZ10a St. Francois Igneous Glade/Oak Forest Knobs

OZ10b St. Francois Dolomite Glade/Oak Woodland Basins

OZ10c Roselle Oak Woodland Upland Igneous Plain

OZ10d St. Francois Oak-Pine Woodland/Forest Hills

Public Lands - State

County Boundaries

Ecological Subsection Boundaries

Major Roads

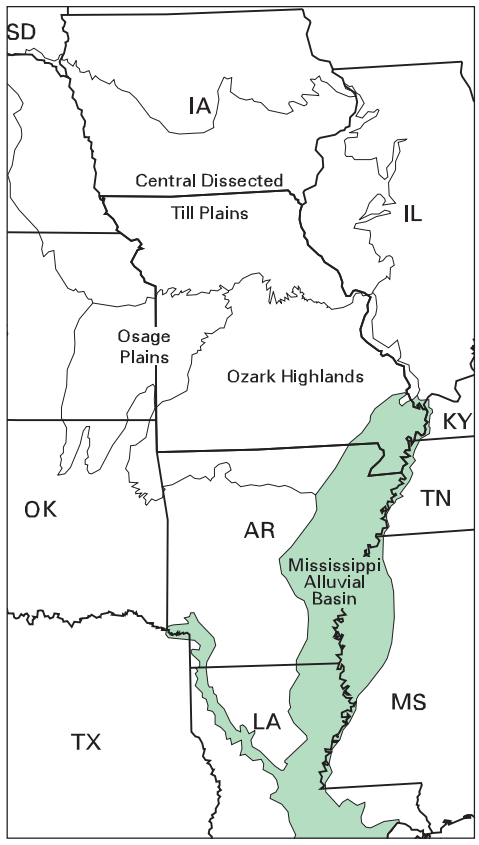
US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi

0 10 20 30 km

MB Mississippi River Alluvial Basin Section



The Mississippi River Alluvial Basin Section extends from southeastern Missouri southward down the broad Mississippi River alluvial plain to the Gulf of Mexico. It includes a complex array of alluvial surfaces formed during the long evolution of the drainage system since the close of the Tertiary Period. The section in Missouri is the northernmost location for some subtropical species and the westernmost location for some eastern species. Most of the section was formerly poorly drained. In the twentieth century extensive hydrological engineering for land drainage and flood protection has converted virtually all of the alluvial plain surface to cropland.

Jim Rathert

The section is subdivided into fourteen subsections, four of which occur in southeastern Missouri. Crowley's Ridge Subsection, the only nonalluvial portion, consists of a narrow, loess-covered ridge that projects above the alluvial plain. The Black River Alluvial Plain Subsection occupies the lowlands west of Crowley's Ridge, and the Mississippi River Alluvial Plain Subsection comprises the lowlands to the east. These two differ chiefly by the texture of the alluvium, with loamy textures to the west and clayey textures to the east. The St. Francis Alluvial Plain Subsection extends northward from Arkansas as a slightly elevated, coarse-textured soils region on the southeast side of Crowley's Ridge. These subsections and their landtype associations are described more fully on the following pages.

MB1
BLACK RIVER ALLUVIAL PLAIN SUBSECTION

(see map pg. 196–197)

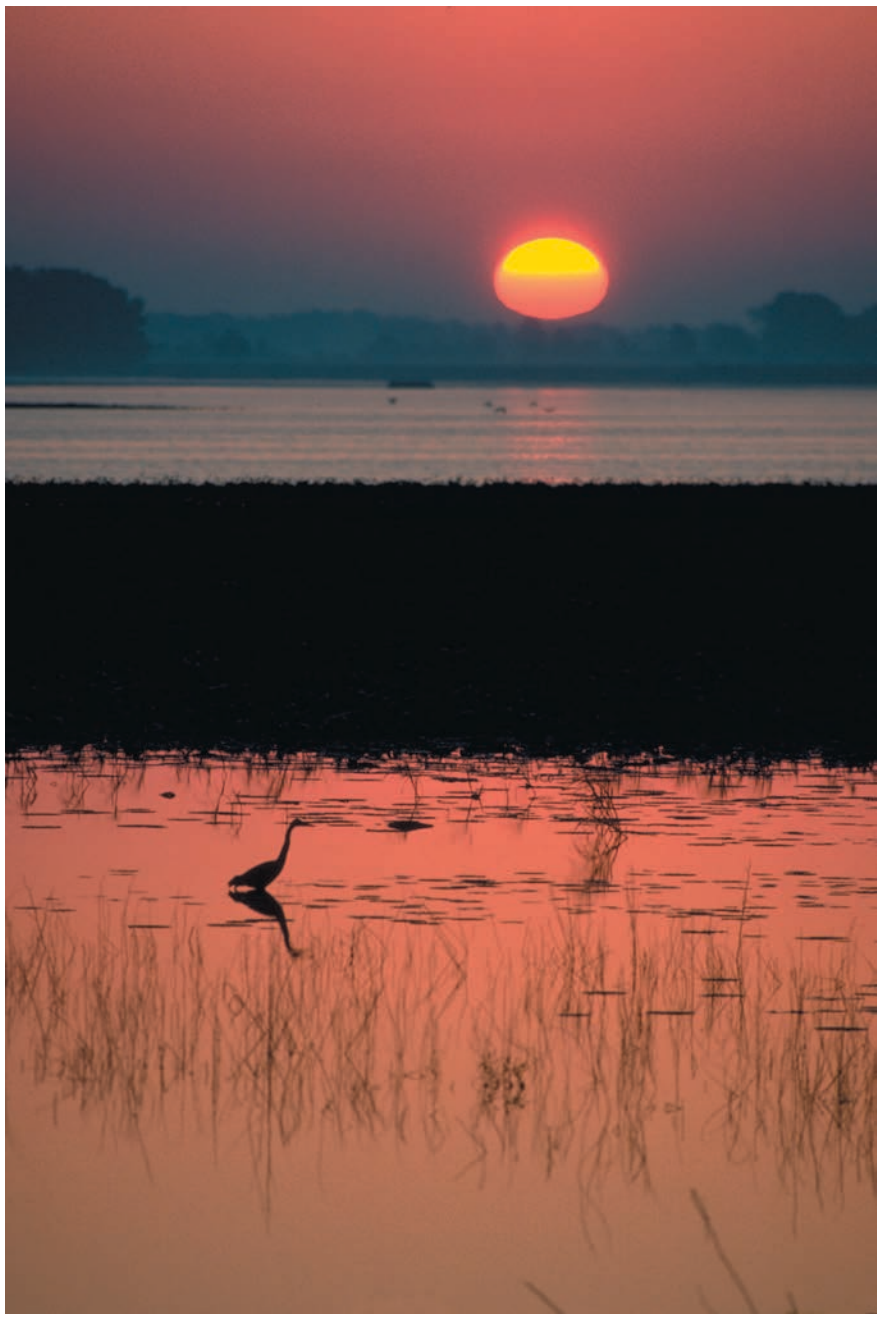
GENERAL DESCRIPTION

The subsection is a silty and sandy alluvial plain of very low relief that includes some tracts of windblown sands and some natural wetlands. Presettlement vegetation was primarily bottomland forest with scattered flatwoods, swamps, marshes, and sand prairies. In addition, this subsection contains dune and swale areas that support rare species. Most of the land has been drained and cleared of its former forest cover and is in cropland. However, several significant remnants of natural land cover are in public ownership.

LOCATION AND BOUNDARIES

The subsection lies in southeastern Missouri and comprises approximately half of Butler County and minor portions of Cape Girardeau, Bollinger, Wayne, Stoddard, Dunklin, and Ripley Counties. On its northwestern side the very conspicuous Ozark Escarpment separates the subsection from the Ozark Highlands Section. On its southeastern side the boundary with Crowley's Ridge is topographically blurred. It is drawn where the alluvial soils of this alluvial plain change into the colluvial, loess, and residual soils of Crowley's Ridge. The northeastern boundary with the Mississippi River Alluvial Plain Subsection lies along the edge of a pronounced alluvial terrace that stands 20 feet higher in this subsection. The Black River Alluvial Plain Subsection extends much farther southward into Arkansas, where it includes the White River alluvial plain.

Wetland remnants in the bootheel provide important habitat for numerous species.



Jim Rathert

CLIMATE

Mean annual precipitation is 48–49 inches. Precipitation is rather equally distributed throughout the year, with most months receiving an average of 3–5 inches. Annual snowfall averages 8 inches. Mean January minimum daily temperature is 22°, and mean July maximum daily temperature is 91°. The growing season is among the longest in Missouri, averaging 220–235 days. Because of the extremely low relief of this subsection, microclimatic variations are minimal.

TOPOGRAPHY AND GEOLOGY

The subsection is defined as the conterminous alluvial plains of several streams coming into it from the adjacent Ozark Highlands Section: Whitewater, Castor, St. Francis, Black, Little Black, and smaller streams. Some thousands of years earlier this subsection was the alluvial plain of the ancient Mississippi River that flowed along the base of the Ozark Escarpment. Thus, the more recent alluvium of the Ozark streams is a veneer on top of other alluvial materials derived from quite distant sources and deposited by the Mississippi River in late Pleistocene and Holocene times. Bedrock is usually deeper than 50 feet beneath the present surface. Bedrock projects above the surface to form a cluster of small isolated hills ("island hills") of dolomite (loess-capped) in the northernmost portion of the subsection. They represent erosional remnants left behind when the Mississippi River was creating this broad valley. Hickory Ridge, the largest of these, is included as a piece of the Crowley's Ridge Subsection. Alluvium brought into the valley by Ozark streams forms low alluvial fans spreading out along the Ozark Escarpment. The alluvium also created low natural levees along the rivers as they cross the alluvial plain. Mingo Swamp, for instance, is isolated by natural levees from the Castor and St. Francis Rivers. The subsection has several prominent tracts of windblown sands, or sand hills, in Butler County. Except for the bedrock hills, local relief on the alluvial plain is only 10–25 feet. The plain as a whole slopes southward at a rate of 1–1.5 feet per mile. It lies, on the average, 20–30 feet higher than the Mississippi River Alluvial Plain Subsection at the same latitude on the eastern side of Crowley's Ridge.

SOILS

The soils in this subsection are all very deep and were formed in alluvial sediments. Most of the soils are on high stream-terrace positions and have well-developed subsoils. Foley soils are poorly drained and have silty clay loam subsoils that are sodium-enriched. Jackport soils have clayey subsoils that are subject to strong shrinking and swelling. Bosket soils are well drained with loamy subsoils and are on natural levees above the poorly drained Tuckerman soils.

HYDROLOGY

The subsection contains portions of the drainage basins of several rivers, all of them (excluding those in the extreme northern end of the subsection) eventually tributary to the White River in Arkansas. These include the St. Francis, Black, and Little Black Rivers. All of these rivers have headwaters in the Ozarks Highlands and carry coarse bedloads into this subsection. On this alluvial plain, however, the rivers have lower gradients and lower velocities and change into ones transporting silts and clays in suspension. Natural channels are in silt, clay, and sand and have extremely meandering channels. Some have been channelized as part of the hydrologic engineering that transformed the plain into cropland. In the northern part of the subsection is the Headwaters Diversion Channel that redirects the water of the Castor and Whitewater Rivers eastward directly to the Mississippi River. Floods on the St. Francis and Black Rivers have been greatly minimized by the construction of flood-control reservoirs on their upper courses. Much of the subsection was seasonally or permanently inundated until the twentieth century. The wetlands have been almost completely drained by ditching, and the ditches are periodically dredged for maintenance. The largest remaining single natural wetland tract is Mingo Swamp and adjacent Duck Creek Conservation Area. This wetland lies in a low-lying pocket trapped between the Ozark Escarpment and Crowley's Ridge and is blocked on both ends by alluvial fans. Efforts to drain it were unsuccessful. Water quality in the subsection is seriously affected by agricultural runoff.

TERRESTRIAL NATURAL COMMUNITIES

Historic. This subsection was originally a complex mosaic of marshes, swamps, bottomland forests, and flatwoods. Higher terraces were dominated by pin oak–willow oak bottomland forest and bottomland flatwoods, interspersed with frequent fingers of lower, wetter bottomland forest and swamp. Lower, more clayey terraces and alluvial plains had more frequent mixed-hardwood wet bottomland forest with overcup oak, Nuttall's oak, swamp chestnut oak, pin oak, sweetgum, water hickory, pumpkin ash, and a myriad of other, mainly southeastern, species. Swamps and marshes were more frequent in these lower positions. Unusual dune and swale communities were associated with sand hills and plains, including sand prairie and savanna openings.

Current. Today, the subsection is over 95 percent cropland. In addition to Mingo National Wildlife Refuge, several other large remnants in conservation ownership include Duck Creek, Big Cane, Coon Island, Otter Slough, and Wilhelmina Conservation Areas. Most remnants have an altered hydrologic regime that is associated with changes in composition and structure and drainage of adjacent croplands.

Major Natural Community Types

Pin Oak–Willow Oak/Deciduous Holly Wet Bottomland Forest (SEMO)

Pin Oak, Post Oak, Cherrybark Oak Lowland Flatwoods

Overcup Oak–Water Hickory (Sweetgum)/Swamp Privet Wet Bottomland Forest

Cypress, Tupelo Swamp

Midwest Mixed Emergent Marsh

Rare or Restricted Natural Communities. The large marshes and bottomland flatwoods typical of this subsection may have been more abundant here than in other subsections. Certainly, the uncommon dune and swale communities are largely restricted to this subsection. Large, high-quality remnants of native ecosystems are rare.

NATURAL DISTURBANCES

Flooding played a significant role in the creation and maintenance of the wetland mosaic that was native to this ecoregion. In addition, burning by Native Americans likely contributed to prairie openings and to the composition and structure of flatwoods.

RARE OR ENDANGERED SPECIES

The subsection contains more than 450 records of 117 state-listed species. This is an exceptionally high number given the almost complete conversion to agriculture. Many of the rare species are fish, reptiles, and amphibians associated with the streams and backwaters of the region. Bottomland forest, swamp, and dune-swale habitats are also important to rare species. Three species of federal concern include bald eagle *(Heliaeetus leucocephalus),* pink mucket *(Lampsilis abrupta),* and pondberry *(Lindera melissafolium).* Pondberry and eight other species are confined to this subsection within Missouri.

NATURAL AREAS

There are four designated Natural Areas in the Black River Alluvial Plain Subsection. Bradyville contains a complex of bottomland forest types. Otter Slough and Allred Lake are outstanding swamps, and Sand Ponds protects the dune and swale system and its distinctive species.

PUBLIC LANDS

The subsection has more than 39,000 acres of public land; this is the most of all subsections in the Mississippi River Alluvial Basin Section in Missouri. Nearly half of this acreage (19,000 acres) is associated with Mingo National Wildlife Refuge. The Missouri Department of Conservation owns almost 20,000 acres, including Big Cane, Coon Island, Duck Creek, Otter Slough, Sand Ponds, and Wilhelmina Conservation Areas. The Nature Conservancy owns 250 acres adjacent to Sand Ponds.

Jim Rathert

Elevated boardwalks at Allred Lake and Big Oak Tree Natural Areas allow visitors to walk out in the swamps.

HUMAN GEOGRAPHY

Demographics. Indians, especially Quapaw, used this region for hunting and other food resources and established camps in it. Eastern Indians who were moving west in the early nineteenth century also lived in the subsection for various lengths of time. Americans began arriving in the early years of the nineteenth century, but their use of these wetlands was mostly for trapping and hunting. The people who settled the subsection were old-stock Americans from a variety of states of the middle and deep South. Some were migrants from the nearby Ozarks. Large numbers of African-Americans and Anglo-Americans were recruited for labor during the rapid expansion of agriculture in the first half of the twentieth century. Since mid-twentieth-century when agricultural mechanization was mostly completed, rural sections have lost significant amounts of people, and the African-American component has dwindled considerably. Some rural areas have less than one tenth of their population of 1940.

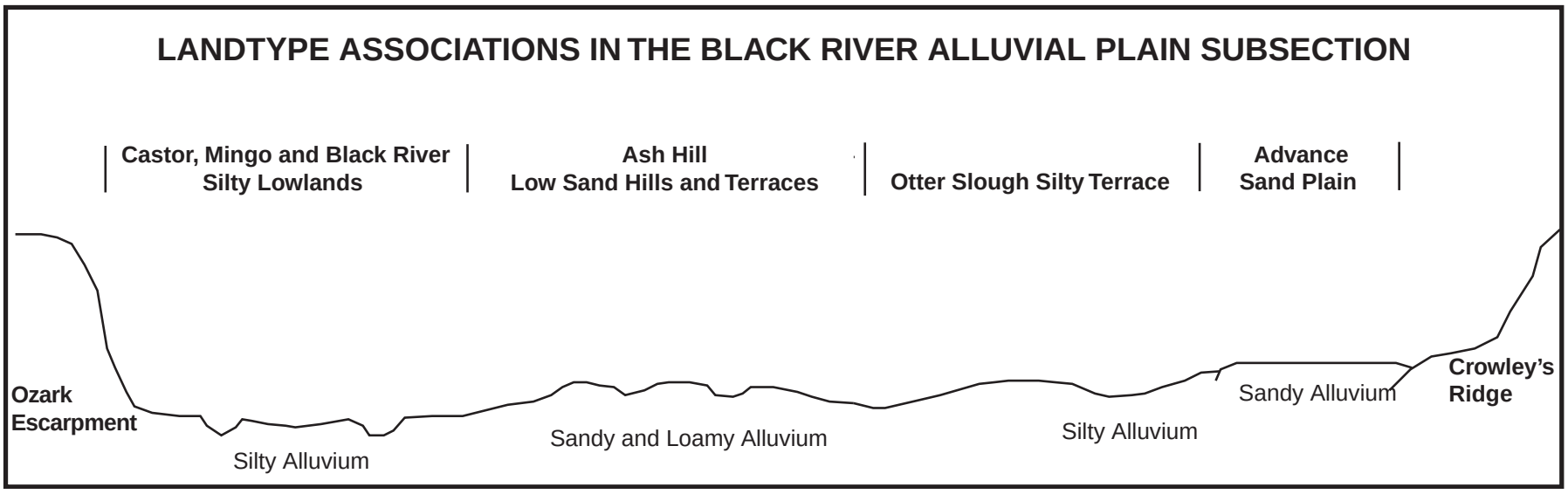
Economics and Land Use. A few elevated, better-drained tracts were occupied early by subsistence farmers. In general, however, the region could not be permanently settled for agriculture until drainage projects were undertaken after the beginning of the twentieth century. After timber was cut and drainage ditches dredged, the land was put into cotton and other crops. By mid-century a thorough landscape change had been accomplished. Only a few wetlands were not converted. Land use is overwhelmingly cropland, chiefly soybeans, wheat, corn, cotton, and rice; livestock are rare. Timber occurs in undrained wetlands, such as Mingo and Duck Creek, and along the larger natural rivers. The economy is overwhelmingly agricultural. Commercial and light industrial activity is in the Poplar Bluff area.

LANDTYPE ASSOCIATIONS

The Black River Subsection has been broken into six landtype associations (LTAs). They range in character from silty lowlands, through silty terraces, to sand hills and plains. The LTAs are described briefly in the following table and are illustrated on a map.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Black River Alluvial Plain Subsection, though heavily drained and converted to agriculture, has an exceptional number of sizeable remnants of native vegetation. However, remnants often suffer the effects of altered hydrology and fragmentation. Expanding the area of influence and size of these systems to minimize hydrological and fragmentation effects will assist in their long-term conservation. Concentrating continued conservation and restoration efforts around existing public lands and other privately owned remnants will ensure the long-term sustainability of larger areas. This will ultimately require better integration of agricultural and natural ecosystems.



(see landtype associations map pg. 196–197)

LANDTYPE ASSOCIATIONS IN THE BLACK RIVER ALLUVIAL PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
MB1a Black River Silty Lowland	The LTA occupies the alluvial plain west of the St. Francis River and drained by the Black, Little Black, and Cane Creek systems, but excluding the sand hills lying in Butler and Ripley Counties. The northwestern boundary is the Ozark Escarpment, and the southern is the Arkansas state line. Other boundaries mark changes to sandier soils of the sand hills.	The LTA consists of low-lying, silty alluvial plains constructed from materials with a strong Ozarkian influence; much of it is loess-derived sediment. Relief is 10–20 feet within a square mile. Originally, the LTA was drained by sloughs and slow moving, meandering streams and had oak and mixed-bottomland hardwood forests interspersed with marshes and swamps in the lowest places. Today, most streams have been channelized and leveed and other lands have been ditched to reduce soil wetness and enhance drainage. Most of the LTA is now cropland, and remnants of native vegetation, though numerous, are small and isolated. A large, significant cluster of native vegetation and rare species occurs on the Arkansas border between Big Cane and Coon Island Conservation Areas. Shield crayfish *(Faxonella clypeata)* and bankclimber *(Plectomerus dombeyanus),* restricted to this subsection, have most of their records in this LTA.
MB1b Ash Hill Low Sand Hills and Terraces	The LTA comprises three disjunct tracts of sand hills west of the St. Francis River in Butler and Ripley Counties. Boundaries are based on soil surveys that delimit slightly higher sand hills and terraces.	The LTA consists of low sand hills and terraces slightly elevated (10–20 feet) above neighboring alluvial plains. Local relief is 20 feet; slopes are very gentle. Soils are distinctively sandy and loamy, but silty in lower swales. Oak woodlands, savannas, and small prairies formerly occupied higher, well-drained areas. Dispersed throughout were swales and linear depressions with wet bottomland forest and shrub swamps containing federally listed pondberry and rare corkwood *(Leitneria floridana).* Today, the LTA is mainly cropland with several dune-swale and lowland swamp remnants in conservation ownership, including Sand Ponds and Allred Lake Natural Areas and Corkwood and Coon Island Conservation Areas. During the dry 1930s and again in the 1950s many of the cultivated sandy surfaces were seriously wind eroded.
MB1c Otter Slough Silty Terrace	The LTA occupies an elevated, older terrace between Crowley's Ridge and the St. Francis River in Stoddard and Butler Counties. The eastern boundary is Crowley's Ridge. The southern boundary is the Arkansas state line. The western boundary is the levee along the St. Francis River. Other boundaries mark changes in soils.	The LTA consists of a slightly elevated, silty terrace formed in redeposited loess and other silty alluvium with local relief no more than 10 feet. It is slightly higher and better drained than the similar Black River Silty Lowland to the west. Consequently, oak flatwoods and small prairie openings were more common in this LTA, but these were interrupted by wet bottomland forest and swamps. Today, a network of straight drainage ditches drains most the area and cropland dominates. Native vegetation remnants are small and isolated. Clusters of larger patches of native vegetation and rare species occur in the vicinity of Otter Slough and Wilhelmina Conservation Areas.

(table continued on pg. 186)

LANDTYPE ASSOCIATIONS IN THE BLACK RIVER ALLUVIAL PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
MB1d Mingo Silty Lowland	The LTA occupies the low plain between the Castor and St. Francis Rivers. The northern and southern boundaries are the natural levees of these two rivers. The other boundaries are Crowley's Ridge and the Ozark Escarpment.	The LTA consists of the alluvial plain trapped between the alluvial fans of the Castor and St. Francis Rivers. Lying lower than all the surrounding land, it has been difficult to drain by gravity flow and attempts have largely failed. The straight drainage ditches, however, remain in the landscape. Relief is less than 10 feet. Much of the LTA is perennially or seasonally covered with shallow water, and much of the rest has water-logged soils. The center of the LTA is dominated by Mingo Swamp National Wildlife Area and the Duck Creek Conservation Area, which together constitute the largest tract of intact ecosystems of the Mississippi River Alluvial Basin Section in Missouri. Numerous outstanding natural communities and rare species occur. The northern and southern fourths, those closest to the two enclosing rivers, are largely cropland.
MB1e Castor River Silty Lowland	The LTA occupies a narrow lowland between Hickory Ridge and the Ozark Escarpment extending southwest to include the Castor River alluvial plain north of Crowley's Ridge. The northeastern boundary is the outer edge of a prominent terrace scarp that drops off 20 feet to a lower surface.	The LTA consists of an alluvial plain and associated terraces, formerly poorly drained, through which the dredged Headwater Drainage Channel now captures the Castor River and other Ozark streams and diverts their flow eastward across this landscape to the Whitewater River and on to the Mississippi River. Historically the LTA was similar to Mingo but was successfully drained and is now in productive cropland. Two substantial patches of bottomland timber remain in the western third of the area at Dark Cypress Swamp.
MB1f Advance Sand Plain	The LTA occupies slightly elevated sand plain between the western half of Hickory Ridge and the northern tip of Crowley's Ridge with the town of Advance at its center. The eastern boundary is a prominent terrace scarp that drops more than 20 feet to lower land. The western boundary marks a change in soils along the Castor River.	The small LTA consists of a slightly elevated sand plain of sandy and loamy materials older than those of the alluvial plains at its ends. Soils are silty and loamy where loess has washed into it from surrounding ridges. Historically the LTA was oak woodland and savanna on well-drained, sandy soils. Today, after ditching and draining, cropland and improved pasture dominate.

Jim Rathert

Pondberry is a federally listed endangered species known only from swale ponds in dune areas of the Mississippi River Alluvial Basin Section in Missouri and Arkansas.

MB2
CROWLEY'S RIDGE SUBSECTION

(see map pg. 196–197)

GENERAL DESCRIPTION

Crowley's Ridge Subsection is a long ridge that rises 100–250 feet above the surrounding alluvial plains. It is an erosional remnant that has had the Mississippi River flow on both sides and reduce it to its present size. The ridge has a bedrock core on top of which are alluvial gravels and sands, the whole of it capped deeply with wind-deposited loess. Loess soils are highly erodible and have been washed by natural and induced processes into lower elevations. Presettlement vegetation was oak and mixed-hardwood woodland and forest, including beech and other eastern mesophytic species. Land cover now is pasture, woods on steeper slopes, and row crops on gentle colluvial slopes.

LOCATION AND BOUNDARIES

The subsection lies in southeastern Missouri between the Mississippi River alluvial plain to the east and the Black River alluvial plain to the west. The ridge lies mostly in Stoddard County but extends through northern Dunklin County to the Arkansas state line and then continues much farther southward in Arkansas. The eastern and northwestern boundaries are a sharp bluff line, a noticeable topographic break with the flat alluvial plain, but the western boundary is conceptually placed at the base of a gentle slope that merges very gradually with the alluvial plain. The boundary is drawn where loess and colluvial soils of Crowley's Ridge change into the true alluvial soils of the Black River Alluvial Plain Subsection.

CLIMATE

Mean annual precipitation is 49–50 inches. It is rather equally distributed throughout the year with most months receiving an average of 3–5 inches. Annual snowfall averages 8 inches. Mean January minimum daily temperature is 24°, and mean July maximum daily temperature is 91°. The growing season is among the longest in Missouri, averaging 220–235 days. Because of the height of this narrow ridge above neighboring plains, microclimatic variations are significant in regards to temperature and are a reason why peach orchardists can prosper on the ridge.

TOPOGRAPHY AND GEOLOGY

The subsection lies on the southeastern flank of the broad Ozark uplift. Although geographically disconnected from the Ozarks proper, the formations of the nearest portions of the Ozarks continue their southeastern dip into Crowley's Ridge Subsection. Older Ozark formations, chiefly Ordovician dolomites and limestones, underlie the ridge's northwestern side. Much more recent sandstones and clays of the Cretaceous and Tertiary periods overlap the Ordovician formations and underlie the eastern and southern portions of the ridge. In addition, Quaternary alluvial materials consisting mainly of alluvial gravels and sands are deposited on top of the bedrock. Finally, all of these are buried under thick Pleistocene loess (up to 50 feet), but they are exposed in deep ravines and valleys. The ridge is topographically asymmetrical. It is noticeably higher on its eastern side, at the ridge's drainage divide, and slopes to the northwest or west. Local relief is as high as 250 feet on the higher eastern side, which stands as a bold erosional escarpment above the adjacent alluvial plain. Relief is much less on the western slopes, which grade almost imperceptibly onto the adjacent alluvial plain. Land use has significantly increased stream erosion and gullying of the erodible loess surface and caused its redeposition at the base of slopes as aprons of colluvium. The ridge has been cut through completely by the valley of the Castor River in northern Stoddard County. The ridge is very low and narrow in its southern extension in northern Dunklin County and has the appearance of an alluvial terrace. The hilly tract known as the Benton Hills (Commerce Hills) along the Mississippi River in Scott County, which is commonly considered part of Crowley's Ridge in the historical evolution of drainage in the southeastern lowlands of Missouri, is classified ecologically as part of the Ozark Highlands Section. In many places in Stoddard County, Crowley's Ridge has been mined for gravel, sands, and clay.

SOILS

The soils in this subsection are all very deep. The dominant soils are the Memphis and Loring series, both formed in very deep loess. Both formed under forest and have thin silt loam surface layers over silt loam to silty clay loam subsoils. Loring soils have a root-restricting fragipan. Falaya and Zachary soils formed in the alluvial outwash from the silty loess uplands and are much less extensive than are the Memphis and Loring soils. Falaya soils are somewhat poorly drained silt loams with no subsoil development, whereas Zachary soils are poorly drained with silty clay loam subsoils.

HYDROLOGY

The subsection contains the headwaters of small streams that drain into the surrounding alluvial plains, with the exception of the Castor River, which cuts across the subsection. Most headwater streams are intermittent or ephemeral; some have been converted into drainage ditches. When flowing, the streams carry high suspended loads. The Castor, whose upper basin in the Ozarks has been diverted to the Mississippi River via the Headwaters Diversion Channel, now has a low-gradient, aggrading channel. Water quality is seriously compromised by agricultural runoff. There are no natural ponds or lakes, but stock-watering ponds are numerous.

TERRESTRIAL NATURAL COMMUNITIES

Historic. Oak woodlands occupied ridges, exposed slopes, and sandy or thin soils. Mixed-hardwood forest, with American beech, tulip poplar, and other eastern mesophytic species, dominated protected slopes. Unique acid-seep communities occurred in valleys, especially where emerging from alluvial sands and gravels. Bottomland forest with mixed hardwood species mostly confined to this region of Missouri occupied the alluvial bottoms.

Current. Most of the upland surface has been converted to nonnative, cool-season grass pasture. Bottoms are largely cropped. Only the roughest lands have second-growth timber. Mining has destroyed many of the acid seeps.

Major Natural Community Types

Beech, Oak, Tulip Tree Mesic Loess Forest

Beech, Sugar Maple, Sweetgum Mesic Sand Forest

Black Oak, White Oak–Hickory Dry-Mesic Glaciated Forest

Swamp Chestnut Oak, Sweetgum Wet-Mesic Bottomland Forest

Post Oak, Blackjack Oak/Bluestem Dry Sand Woodland

Central White Oak Dry-Mesic Glaciated Woodland

Rare or Restricted Natural Communities. The sand woodlands and forest communities, as well as the mesic forests, were unique to here and to coves along the Mississippi. The acid seeps emerging from gravel deposits are also unique to Crowley's Ridge. All natural communities are rare today.

NATURAL DISTURBANCES

Drought and fire helped maintain the open woodlands. Backwater flooding up the valleys from the alluvial plains created a unique transitional environment.

RARE OR ENDANGERED SPECIES

Crowley's Ridge Subsection contains more than 170 records of 86 state-listed species. Many unique plant species are associated with the acid seeps and springs, including 12 species whose occurrence in Missouri is confined to the ecoregion. Bottomland forest and swamps and upland woodlands supported many rare species. There are no species of federal concern known in this subsection.

NATURAL AREAS

Crowley's Ridge has two designated Natural Areas. Beech Springs supports unique mesic forest communities, and Holly Ridge has outstanding acid seeps and springs with over 30 records of unique species.

PUBLIC LANDS

The subsection has almost 4,000 acres of public land, most of it associated with Crowley's Ridge and Holly Ridge Conservation Areas. A small portion of Mingo National Wildlife Refuge (700 acres) extends onto the ridge.

HUMAN GEOGRAPHY

Demographics. Indians made considerable use of Crowley's Ridge for a very long period of time as witnessed by the large number of archaeological sites on it.

Americans began to farm the area in the 1830s and the whole ridge was occupied by the 1860s. Settlers were dominantly old-stock Americans, with slaves, from Kentucky, Tennessee, and adjacent states. Others, including African Americans, came into the subsection in the twentieth century.

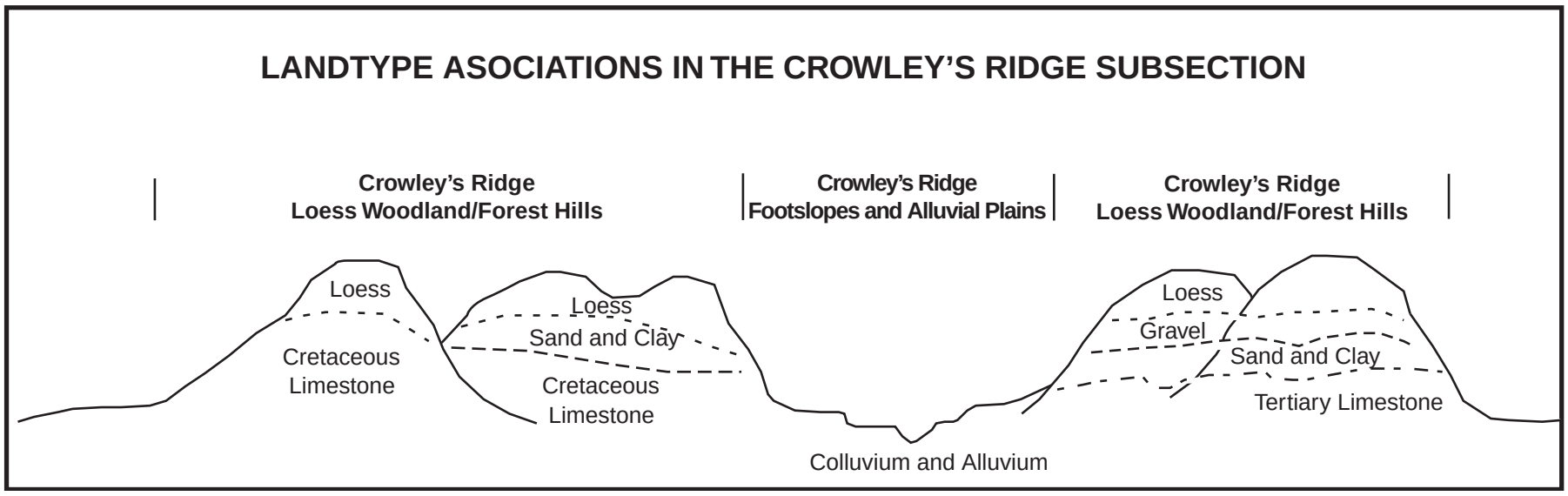
Economics and Land Use. Early farms were small-scale and included livestock and crops. Agriculture became commercialized with the coming of railroads in the 1870s. In the twentieth century farms were consolidated and marginal units on eroded soils abandoned. Fruit-growing took hold. Corn, soybeans, wheat, hay, and livestock are also products of the ridge. Urban activities focus on Bloomfield and Dexter. Timber has come back on the steeper slopes and the most gullied tracts. The economy is agriculture-based and includes both crops and livestock. Orchards are locally important. Small towns provide employment in the commercial and service sectors. Population grew fast until the twentieth century and since has grown at a much slower rate.

LANDTYPE ASSOCIATIONS

Crowley's Ridge Subsection is subdivided into two landtype associations (LTAs); one is recognized for the uplands and the other is distinguished by footslopes and alluvial plains. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

Crowley's Ridge is a unique physical feature in Missouri with correspondingly unusual ecosystems, but most lands have been converted to agricultural use and little native vegetation remains. However, there are significant remnants, some of which are already in conservation ownership. Continued efforts to consolidate these and protect other small and significant remnants will ensure their future.



(see landtype associations map pg. 196–197)

LANDTYPE ASSOCIATIONS IN THE CROWLEY'S RIDGE SUBSECTION

LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
The LTA lies on the upland surface of Crowley's Ridge. Boundaries are drawn at the base of slopes to exclude the footslopes and alluvial plains.	The LTA consists of loess-covered hills having generally 100–150 feet of local relief and rising to 250 feet on the eastern margins. Slopes are steep in the more deeply dissected eastern margins and bluffs but are moderate to gentle elsewhere. Steeper slopes expose Ordovician carbonate bedrock and alluvial gravels. Historically the LTA was oak and mixed-hardwood woodland and forest with inclusions of eastern mesophytic species. Today the LTA is mainly pasture on severely eroded soils, with scattered second-growth timber on the steepest lands.
The LTA lies in the toeslopes and alluvial bottoms of Crowley's Ridge and is in several separate segments. Boundaries encompass depositional surfaces as determined by soil surveys.	The highly irregularly shaped LTA consists of depositional surfaces within Crowley's Ridge. These are primarily gently sloping footslopes and toeslopes composed of loess washed from upper slopes and alluvial bottoms aggraded in historic times. The LTA is transitional between the uplands of Crowley's Ridge and the alluvial plains surrounding the ridge. Soils are naturally poorly drained in fine-textured alluvium, but ditching has drained them. Historically the LTA was mixed-bottomland forest and swamp with occasional springs and acid seeps. Today it is almost completely cropland with a few remnant seeps and forests.

Jim Rathert

Duck Creek Conservation Area is an outstanding place to get a feel for what the bootheel used to be like.

MB3
ST. FRANCIS RIVER ALLUVIAL PLAIN SUBSECTION

(see map pg. 196–197)

GENERAL DESCRIPTION

This subsection is an older Pleistocene terrace that lies at an elevation intermediate between Crowley's Ridge to the west and the alluvial plain to the east. The surface is generally sandy but is loamy in swales of old, braided channels that flowed on the terrace. It is associated with the St. Francis River, on the eastern side of Crowley's Ridge, and extends far south into Arkansas. Presettlement vegetation was a mosaic of prairie, oak savanna, bottomland forest, and swamp. Land cover is now virtually all cropland, except for narrow and isolated timber along stream courses. Relatively large patches of native vegetation line the leveed St. Francis River in the vicinity of Ben Cash Conservation Area.

LOCATION AND BOUNDARIES

This long, narrow subsection lies in extreme southeastern Missouri on the western side of the bootheel and represents the northern tip of a region much more extensive in Arkansas. Its western boundary is the base of Crowley's Ridge and, farther south, the St. Francis River, which is the Arkansas state line. The eastern boundary is a prominent alluvial terrace between this higher surface and the lower elevation of the Little River lowlands. It is so prominent that it is used for the county line between Dunklin and New Madrid Counties. Because of its small size and similarity to the Mississippi River Alluvial Plain Subsection, this subsection may be considered part of that subsection for most purposes.

CLIMATE

Mean annual precipitation is 50–52 inches, which is one of the highest in Missouri, with all months receiving an average of 3–5.5 inches. Precipitation is rather equally distributed throughout the year. Annual snowfall averages only 8 inches. Mean January minimum daily temperature is 25°, and mean July maximum daily temperature is 91°. The growing season is one of the longest in Missouri, averaging 235–250 days. Because of the extremely low relief of this subsection, microclimatic variations due to topography are virtually nonexistent.

TOPOGRAPHY AND GEOLOGY

The subsection consists of a sandy and loamy alluvial terrace formed by sands and silts deposited during late- and postglacial times by the Ohio and Mississippi Rivers. It became a terrace when left behind by the degradation (lowering) of the Mississippi alluvial plain to the east during the last few thousand years. The St. Francis River has subsequently modified the surface below its passage through Crowley's Ridge. Bedrock is deep below the surface. Local relief in Missouri averages less than 20 feet. The alluvial plain is marked by a series of historic braided channels or swales separated by slightly higher historic islands of the braided river system. The eastern edge of the sandy and loamy terrace rises prominently above the lower alluvial plain and is locally known as either the Malden or Kennett Ridge.

SOILS

The soils in this subsection are all very deep and were formed in alluvial sediments. The soils vary in texture, drainage, and degree of soil development. The soil pattern is related to the complex network of natural levees, back swamps, and terraces deposited by both the Mississippi and the ancestral Ohio Rivers. The sandy Malden soils formed in natural levee deposits of the Ohio River, as did the Broseley soils with their fine sandy loam subsoils. Other common soils formed in Mississippi and St. Francis River sediments include the well-drained Dubbs series, with a silty clay loam subsoil, and the somewhat poorly drained Dundee series, with a clay loam subsoil. Clayey slack water soils are less common in this subsection than in other areas of the section, but the clayey Roellen soils are in low-lying sloughs adjacent to Dubbs soils.

HYDROLOGY

This subsection lies entirely within the drainage basin of the St. Francis River. It includes the channel of the St. Francis River along the Arkansas state line and a few small tributaries in Dunklin County, some of which drain off eastward into the Little River drainage district. The St. Francis channel is mostly in silts, clays, and sands and was formerly intensely meandering. The swamps through which it formerly flowed have been largely drained, and the channel has been straightened in places and leveed. The channel gradient is less than 1 foot per mile. The channel has been dammed with "rafts" of logs and other debris that cause water elevations to be higher and nearby soils to be waterlogged. The tributaries serve as drainage ditches. Stream floods are not common, but inflooding (wet or drowned fields from excessive rains) occurs. Water quality is affected by agricultural runoff.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The subsection was formerly a mosaic of sand prairie, savanna, and woodlands on the higher, sandier ridges interspersed with lower, wetter bottomland forest and swamp.

Current. Today the region is extensively leveed, drained, and cropped. Narrow bands of timber occur in the lowest, wettest areas, especially inside the levees of the St. Francis River.

Major Natural Community Types

Post Oak–Blackjack Oak/Bluestem Dry Sand Woodland

Post Oak–Mixed Oak Dry Sand Savanna

Mississippi Embayment Sand Prairie

Pin Oak–Willow Oak/Deciduous Holly Wet Bottomland Forest

Overcup Oak–Water Hickory/Swamp Privet Wet Bottomland Forest

Cypress, Tupelo Swamp

Midwest Mixed Emergent Marsh

Rare or Restricted Natural Communities. Sand prairies, savannas, and woodlands that distinguish the Mississippi alluvial plains also occurred in this subsection, but no remnants are known in this subsection. All natural communities are rare.

NATURAL DISTURBANCES

Flooding played a significant role in the creation and maintenance of the wetland mosaic that was native to this ecoregion. In addition, burning by Native Americans likely contributed to prairie openings and savanna composition and structure.

RARE OR ENDANGERED SPECIES

The St. Francis River Alluvial Plain Subsection contains more than 100 records of 60 state-listed species. Most are associated with the streams and backwaters of the region, but bottomland forests and swamps are also important habitats. Few sand prairie or savanna species are known. No species of federal concern occur, but two species, the Mississippi green water snake *(Nerodia cyclopion)* and a beggar's tick *(Bidens laevis),* have their only state locations in this subsection.

NATURAL AREAS

The subsection has only one designated Natural Area, Cash Swamp, which is an outstanding example of wet bottomland forest and swamp.

PUBLIC LANDS

The only public land (other than a couple of river accesses) is Ben Cash Memorial Conservation Area, which has more than 1,600 acres.

HUMAN GEOGRAPHY

Demographics. The subsection was occupied for long periods of time by various Indian tribes, but especially the Quapaw, as a region of settlement, for hunting, and for passage along the St. Francis River and Crowley's Ridge. Before 1811 French and Americans utilized the natural levees along the St. Francis and the well-drained land of the Malden Ridge for small farms. The great earthquakes of 1811–1812 caused further immigration to halt until the 1830s and 1840s. Population increased

rapidly in the twentieth century following the conversion of the lands to agriculture. In recent decades rural population has been declining, partially offset by the growth of Kennett and Malden.

Economics and Land Use. Agricultural settlement on the alluvial terraces and better-drained lands was sufficiently advanced by the 1840s so that Dunklin County was erected, although farming was semisubsistence. Major settlement of the subsection did not take place until after the turn of the century, when drainage districts were organized, timber was cleared, and ditches were dredged. The economy today is overwhelmingly agricultural, almost all in crops. Livestock does not figure into the economy. More than 90 percent of the nonurban land is in farms, mainly in row crops. Timber is present only between the St. Francis River channel and its high levees and in a very few preserved tracts. Malden and Kennett are commercial and service centers and have also developed some industry.

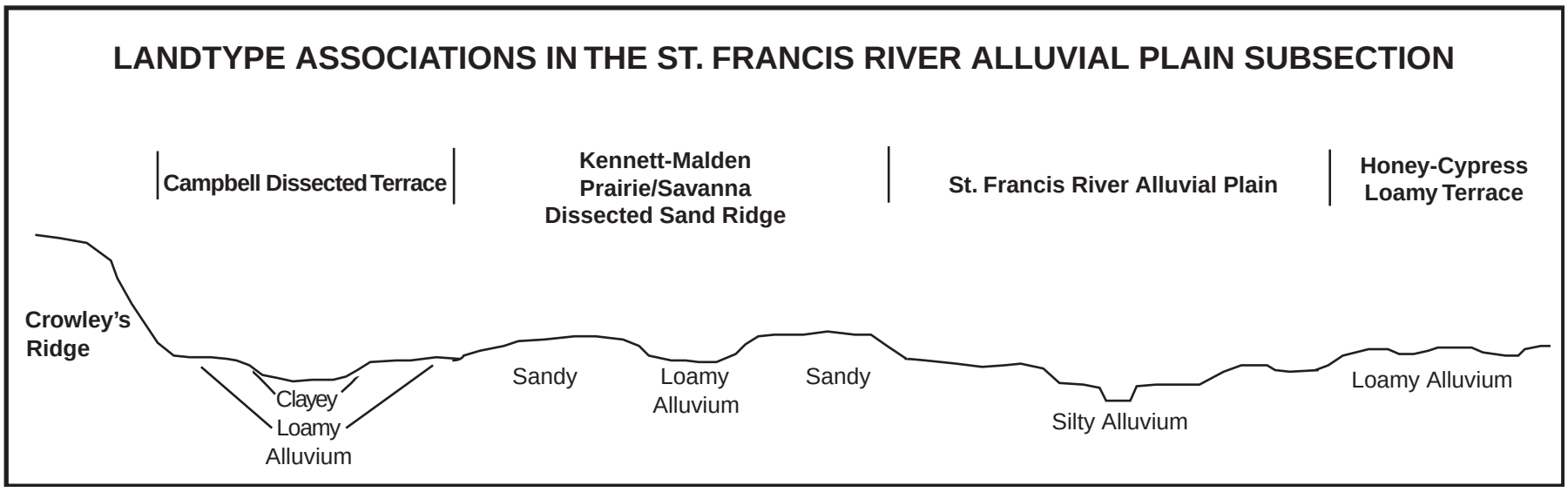
LANDTYPE ASSOCIATIONS

The St. Francis River Alluvial Plain Subsection is subdivided into landtype associations (LTAs). They range in character from the narrow St. Francis River alluvial plain, through dissected silty terraces, to sand ridges, and to dissected plains. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The St. Francis River Alluvial Plain Subsection is thoroughly drained and converted to agriculture. Few parcels of native vegetation remain, and all have altered hydrology. No examples of sand prairie or savanna are known. The best opportunity for native ecosystem conservation occurs along the narrow alluvial plain corridor of the St. Francis River. Restoration activities will ultimately require better integration of agricultural and natural ecosystems, especially in water management.

LANDTYPE ASSOCIATIONS IN THE ST. FRANCIS RIVER ALLUVIAL PLAIN SUBSECTION

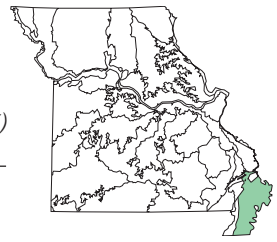


(see landtype associations map pg. 196–197)

LANDTYPE ASSOCIATIONS IN THE ST, FRANCIS RIVER ALLUVIAL PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
MB3a St. Francis River Floodplain	The LTA occupies the long, narrow alluvial plain of the St. Francis River along the Arkansas state line. Boundaries follow the major levee along the river and enclose land subject to frequent flooding.	The LTA consists of an alluvial plain and the channels of the St. Francis River and numerous drainage ditches, enclosed by a high levee system. Wet bottomland forest and swamps border the river, but cropland dominates elsewhere. Few structures or roads are in this LTA. Ben Cash Conservation Area and its vicinity show potential for larger-scale conservation efforts.
MB3b Campbell Dissected Silty Terrace	The LTA occupies a long, narrow, silty terrace between Crowley's Ridge and the Malden Ridge. The western boundary is Crowley's Ridge and the eastern boundary marks a transition to sandy soils.	The LTA consists of an older, silty terrace very slightly dissected by swales that are old channels of a former braided stream. Formerly the LTA was a complex mosaic of woodland and wet bottomland forest and swamp. Now thoroughly drained, it is virtually all cropland.
MB3c Kennett-Malden Prairie/ Savanna Dissected Sand Ridge	The LTA is a long, narrow sand ridge between the lower-lying alluvial plain to the east and the modern St. Francis River alluvial plain to the west. Other boundaries mark a transition to siltier soils.	The LTA consists of a terrace (also called the Malden Ridge or Kennett Ridge) that stands 20–30 feet higher than the alluvial plains on either side and is composed of sandy and silty materials laid down by former braided streams. The pattern is one of higher, well-drained, sandy surfaces broken by lower, poorly drained silty swales in which the drainage ditches run. Historically, sand prairie, savanna, and woodlands occupied the sandy terrace, with forest and swamp on the wetter swales. Today, the LTA is nearly all cropland with very little native vegetation. Development is concentrated along MO 25, which runs the length of the LTA along its eastern escarpment, from Dexter in the north, through Malden, to Kennett in the south.
MB3d Honey-Cypress Loamy Terrace	The LTA is located at the southern end of the Malden Ridge in southern Dunklin County. Boundaries are based on county soil surveys that distinguish the siltier soils of this LTA.	The LTA consists of a complex series of well-drained silty terraces (sometimes called "islands") separated by shallow, poorly drained linear depressions. This LTA has one of the lowest average elevations in Missouri. Local relief is less than 10 feet and barely perceptible. Soils are loamy on the flat terraces and silty in the depressions, which have been ditched and drained. Historically the LTA was bottomland forest and swamp, but today it is all cropland.

MB4
MISSISSIPPI RIVER ALLUVIAL PLAIN SUBSECTION

(see map pg. 196–197)



GENERAL DESCRIPTION

This subsection is essentially the extensive, historic alluvial plain of the Mississippi River on the eastern side of Crowley's Ridge. It also includes the present Mississippi River alluvial plain. In most places it is lower, has finer-textured sediments, and is less well drained than the other three subsections. It is an alluvial plain of remarkably low relief except for sandy alluvial terraces or natural levees that rise 15–30 feet above the general surface. Presettlement vegetation was dominated by wet bottomland forest, swamps, marshes, and oxbow lakes, with sand prairies and savannas on terraces and riverfront forests lining the larger streams. Most of the timber has been cleared and virtually all of the land has been drained. Land cover is now dominantly cropland with timber along the drainage channels and the lowest areas unprotected by levees along the Mississippi River. This subsection contains most of the epicenters in Missouri of earthquakes associated with the New Madrid fault zone.

LOCATION AND BOUNDARIES

The subsection lies in extreme southeastern Missouri and contains the Mississippi River alluvial plain east of Crowley's Ridge with the minor exception of the St. Francis River Alluvial Plain Subsection. It comprises all of Mississippi, New Madrid, and Pemiscot Counties, major portions of Scott, Stoddard, and Dunklin Counties, and a minor portion of Cape Girardeau County. It is bounded on the east entirely by the Mississippi River, which forms the state boundary, and on the south by the Arkansas state line. It is bounded on the southwest by an alluvial terrace that rises to the St. Francis River Alluvial Plain Subsection. It is bounded on the northwest by the abrupt bluff line of Crowley's Ridge and on the far northwest by an alluvial terrace that rises to the Black River Alluvial Plain Subsection. The northern boundary with the Outer Ozarks Subsection (including its separate Benton Hills outlier) is a very conspicuous escarpment. The Mississippi River Alluvial Plain Subsection extends much farther south into Arkansas and Louisiana and across the Mississippi River into Illinois, Kentucky, Tennessee, and Mississippi.

CLIMATE

Mean annual precipitation ranges from 48 inches in the north to 52 inches in the south and is one of the highest in Missouri, with all months receiving an average of 3–5.5 inches. Precipitation is rather equally distributed throughout the year. Annual snowfall averages only 8 inches. Mean January minimum daily temperature is 25°, and mean July maximum daily temperature is 91°. The growing season is one of the longest in Missouri, averaging 220–250 days. Because of the extremely low relief of this subsection, microclimatic variations due to topography are virtually nonexistent.

Jim Rathert

Green treefrogs are common inhabitants of bootheel wetlands.

TOPOGRAPHY AND GEOLOGY

The subsection lies in the northern end of the Mississippi Embayment, a deep structural trough that had been filling with marine sediments until the Pleistocene Epoch, when it became a depositional area for glaciofluvial and other materials brought into it by the Ohio and Mississippi Rivers. The alluvial fill in most places is well over 100 feet thick and consists of a variety of sediment sizes. Surficial materials range from very tight clays laid down in quiet water to coarse sands laid down in more rapidly moving water. In general, the clays occupy lower elevations and the sands occupy higher elevations. Three main fluvial landforms are readily recognized: low, clayey alluvial plains, loamier natural levees near streams, and sandy terraces (locally called "ridges"). Until the twentieth century most of the low, clayey, alluvial plains were poorly drained lands of swamps and open waters, either perennial or seasonal. Some of the lower tracts are thought to have subsided (thus called "sunklands") during the strong earthquakes of 1811–1812. The sandy, alluvial terraces (like the Sikeston Ridge) were not wetlands. Neither was the broad natural levee along the Mississippi River. In the twentieth century the vast majority of the wetlands have been drained through organized drainage districts. A high levee has been built on top of the natural levee along the Mississippi River. The regional slope of the alluvial plain is southward at an average rate of 1–1.5 feet per mile, and thus the straight drainage ditches have reasonably high gradients of 1–1.5 feet per mile in contrast to the meandering channels they replaced with gradients of only a few inches per mile. Local relief in the flatter areas is very low, 3–10 feet within any square mile, but it is 20 feet along the terraces and levees.

SOILS

The soils in this subsection are all very deep and were formed in alluvial sediments from the Mississippi and Ohio Rivers. The soils vary in texture, drainage, and degree of subsoil development. Soils near the Mississippi River have little or no subsoil development. These include the sandy Crevasse soils adjacent to the channel, the somewhat poorly drained, silty Commerce soils, and the clayey, poorly drained Sharkey soils in back swamp positions farther from the river. Also in the broad back swamp area are the Steele soils, characterized by sands deposited over the clayey sediments as "sand boils" during the New Madrid earthquakes of 1811–1812. Old Mississippi River terrace soils with more developed subsoils, such as the loamy, poorly drained Wardell series, interfinger with more recent sediments deposited from the Ohio River, such as the sandy Scotco series. Also interfingered with the old terraces and recent sandy deposits are soils with dark surfaces, such as the loamy, poorly drained Gideon soils, which perhaps formed under wetland grasses and sedges.

HYDROLOGY

The subsection includes (a) the channel of the Mississippi River below Commerce and a short segment south of Cape Girardeau, (b) streams and drainage channels that converge and empty in a single outlet into the Mississippi at New Madrid, (c) streams and numerous drainage channels of the Little River system, which drains into the St. Francis River south of the Arkansas state line, and (d) the lower half of the Headwaters Diversion Channel that diverts water from the Whitewater River and other streams directly to the Mississippi River at Cape Girardeau. The Mississippi River channel is largely stabilized and confined at high water by levees, which may be set back a few miles from the riverbanks, but the channel continues to be morphologically active by constantly reconfiguring its bed. Bed and banks are mainly silty and sandy. River depth reaches over 50 feet. A year-round navigation channel is maintained largely by action of the river itself. Discharge at Thebes, Illinois, averages 205,000 cubic feet per second. Wetlands occur between the channel and the levee in many places. The former, very extensive wetlands of the alluvial plain were almost completely drained and eliminated in the twentieth century by an integrated system of field ditches and drainage channels of organized drainage districts. The largest drainage district is the Little River District, which takes water from the truncated Castor and Whitewater Rivers (which combined create the Little River) and local streams and conveys it to the Arkansas state line through the lowest parts of the alluvial plain. The drainage channels are straight,

with clay and silt bed and banks and bordered by berms created from the dredged material. Some ditches are dredged regularly; others are poorly maintained. Remnants of the intensely meandering former channels remain as wetlands. Stream flooding is rare, largely because the Headwaters Diversion Channel in the northern part of the alluvial plain diverts water of Ozark rivers to the Mississippi so that they do not continue farther south into the alluvial plain. Inflooding (standing water from extensive rains), however, can occur, although the deep ditches usually drain off surface water readily. A few wetlands remain on public lands and along some drainage ditches. Water quality may be seriously compromised by agricultural runoff from intensively farmed fields. Groundwater from deeper formations is abundant. Artesian conditions were formerly present in places. The static water table is kept well below the root zone of the crops by the system of drainage ditches.

TERRESTRIAL NATURAL COMMUNITIES

Historic. The bulk of original vegetation was frequently flooded, wet bottomland forest, swamps, marshes, and oxbow wetlands. Sand prairies, savannas, and woodlands occurred on elevated sandy tracts. Riverfront forests occupied natural levees.

Current. The region is almost entirely in highly productive cropland, mostly row crops. Native vegetation is confined to the lowest, wettest areas, most often on the river side of the levee along the Mississippi or associated with undrained bayous and former channels. Several small, isolated sand prairie and savanna remnants are known in Scott County. Some of the remaining native vegetation is in conservation ownership.

Major Natural Community Types

Sycamore, Cottonwood, Willow Riverfront Forest

Green Ash, American Elm, Sugarberry Riverfront Forest

Pin Oak–Willow Oak/Deciduous Holly Wet Bottomland Forest

Overcup Oak–Water Hickory (Sweetgum) Wet Bottomland Forest

Cypress, Tupelo Swamp

Rare or Restricted Natural Communities. Some of the largest and most widespread wet bottomland forest and swamp complexes occurred in this subsection. In addition, the sand prairies, savannas, and woodlands were unique to this and adjacent subsections. Large sandbars in the Mississippi River were important habitat for interior least terns and other species. All natural communities in the subsection are rare today.

NATURAL DISTURBANCES

Perennial and seasonal flooding had a significant role in the creation and maintenance of the wetland mosaic that was native to this ecoregion. In addition, burning by Indians and American settlers likely contributed to prairie openings and savanna composition and structure.

RARE OR ENDANGERED SPECIES

The subsection contains more than 500 records of 132 state-listed species. Many of the species are fish, amphibians, reptiles, or mussels associated with streams and backwater wetlands. There are also a high number of bottomland forest and swamp plants, and a fair number of unique plants associated with remnants of sand prairies and savannas. Only three species of federal concern are known: bald eagle *(Heliaeetus leucocephalus),* fat pocketbook mussel *(Potamilus capax),* and interior least tern *(Sterna antillarum* var. *athalassos).* In addition, 16 listed species have more than 80 percent of their statewide occurrences in this subsection.

NATURAL AREAS

The subsection has only two designated Natural Areas, Wolf Bayou and Big Oak Tree. These contain outstanding examples of wet bottomland forest, swamps, and oxbows.

PUBLIC LANDS

The Mississippi River Alluvial Plain contains more than 18,000 acres of public land. Big Oak Tree State Park has more than 1,000 acres. The Missouri Department of Conservation owns more than 17,000 acres. Prominent Conservation Areas include Donaldson Point, Gayoso Bend, Hornersville Swamp, Seven Island, Ten Mile Pond, and Wolf Bayou.

HUMAN GEOGRAPHY

Demographics. The subsection was occupied for long periods of time by various Indian groups, but especially the Quapaw, as a region of settlement, for hunting, and for passage along the Mississippi River. Various eastern Indians also occupied the alluvial plain at times during their movement to reservations farther west. Before 1811, French and Americans utilized the natural levees along the Mississippi and other rivers and the higher ground of the Sikeston Ridge for small farms. The great earthquakes of 1811–1812 had a major effect on settlement. Many areas, including New Madrid, experienced population outmigration, and immigration into the region was largely stopped by its subsequent bad reputation, which also included endemic fevers or malaria. The wetlands remained unoccupied, except as productive hunting and trapping areas. Agricultural occupance on the alluvial terraces and better-drained lands was sufficiently advanced by the 1840s so that all of the counties had been erected. Farming was semisubsistence, although there were a few large "plantations" along the Mississippi River. Major settlement of the subsection did not take place until after the turn of the century, when drainage districts were organized. These districts, plus the raising and standardizing of levees along the Mississippi and other rivers, the construction of the Headwaters Diversion Channel, and the construction of flood-control dams and reservoirs on the St. Francis and Black Rivers, made it possible to convert the wetlands into productive agricultural lands. Timber had to be cleared and channels and ditches were dredged. The conversion was nearly completed by mid-twentieth century. The large amounts of labor needed for timber cutting came from the Ozarks and adjacent Kentucky, Tennessee, and Arkansas. The large amounts of labor needed in agriculture, chiefly cotton, came from labor left over from the timber industry and from African American labor (sharecroppers) recruited from farther south in the Mississippi valley. By the mid-twentieth century, the subsection had a rural population three times greater than at the start of the century. All of the other agricultural regions of Missouri were losing population at this time. Mechanization and the introduction of agricultural chemicals replaced much labor after midcentury, and since then the subsection has experienced major population losses, up to one half of the population in some districts. This extreme population loss has not been offset by the growth of towns.

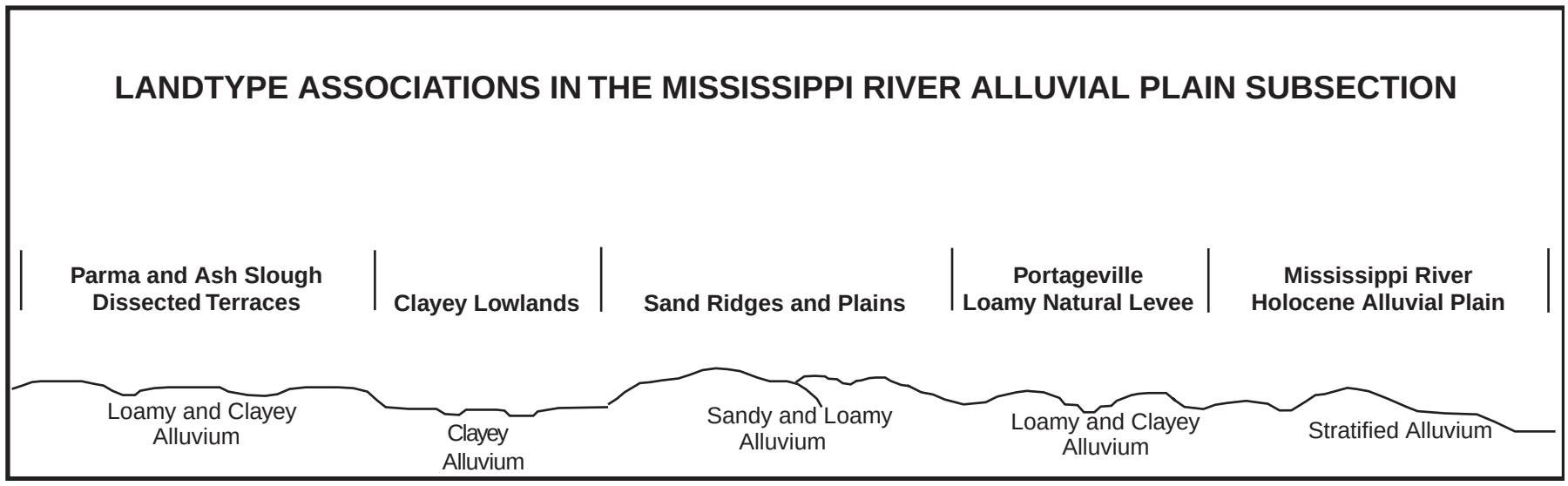
Economics and Land Use. The economy is overwhelmingly agricultural, almost all in crops. Livestock does not figure into the economy. This subsection contains Missouri's most valuable and productive farmland. More than 90 percent of the land is in farms, mainly crops of cotton, soybeans, wheat, corn, sorghum, and rice. Specialty crops, like potatoes, watermelons, and pumpkins, are grown locally. Timber remains only along the larger drainage channels and natural streams, between the Mississippi River channel and its high levee and in a very few preserved tracts. Sikeston, Cape Girardeau, and county seats (Charleston, New Madrid, Benton, and Caruthersville) are commercial and service centers and have also developed some industry. I-55 traverses the subsection from south to north.

LANDTYPE ASSOCIATIONS

The Mississippi River Alluvial Plain Subsection is subdivided into twelve landtype associations (LTAs). They have been delineated to recognize landscapes ranging from the lowest clayey lowlands and bayous, through the more recently deposited, active alluvial plain along the Mississippi, to the elevated silty and sandy terraces and ridges. The distinctive character of each of the LTAs influences the distribution of natural resources and the management challenges and opportunities that exist within the ecoregion. Consequently, they serve as an effective spatial framework for emphasizing different potential land management practices and outcomes. The LTAs are described briefly in the following table.

CONSERVATION CHALLENGES AND OPPORTUNITIES

The Mississippi River Alluvial Plain Subsection, though heavily drained and converted to agriculture, has a large number of sizeable remnants. However, remnants of native vegetation often suffer altered hydrology and fragmentation effects. The only opportunities to conserve sand prairies and savannas and riverfront forests native to this ecological section exist here. Expanding the area of influence and size of these systems to minimize hydrological and fragmentation effects will assist in their long-term conservation. Concentrating continued conservation and restoration efforts around existing public lands and other privately owned remnants might ensure the long-term sustainability of larger areas. This will require better integration of agricultural and natural ecosystems.



(see landtype associations map pg. 196–197)

LANDTYPE ASSOCIATIONS IN THE MISSISSIPPI RIVER ALLUVIAL PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
MB4a Parma Dissected Terrace	The LTA occupies a long alluvial terrace in the western part of the Little River basin, mostly in Stoddard and New Madrid Counties. The western boundary is a distinct rise to the higher Malden Ridge and Crowley's Ridge. The eastern boundary marks a transition to the clay lowlands of the former Little River swamp.	The LTA is an alluvial terrace intermediate in elevation between the lower land to the east and the higher land to the west. It is composed mainly of loamy alluvium with numerous clayey swales of former channels. Local relief is not more than 10 feet. Most soils are poorly developed entisols and inceptisols, intermixed with better-developed alfisols. Historically, the LTA was a mosaic of wet bottomland forest, swamp, and marshes. Today, numerous parallel drainage ditches at mile intervals have drained the surface and allowed almost complete conversion to cropland. Very few substantial patches of native vegetation exist.
MB4b Ash Slough Dissected Terrace	The LTA occupies a long, narrow terrace on the eastern side of the Little River basin in Scott and New Madrid Counties. The eastern boundary is the rise to the Sikeston Ridge (terrace). The western boundary marks a transition to the clay lowlands of the former Little River swamp.	The LTA is a terrace intermediate in elevation between the higher, sandy terrace to the east and the lower clay lowlands to the west. It is composed mainly of loamy alluvium with clayey swales that were former channels. Local relief is not more than 10 feet. Most soils are poorly developed entisols and inceptisols, intermixed with better developed alfisols. Historically, the LTA was a mosaic of wet bottomland forest, swamp, and marshes. Today, numerous drainage ditches have drained the landscape and allowed almost complete conversion to cropland. Very few patches of native vegetation exist.
MB4c Portageville Loamy Natural Levee	The LTA occupies a highly irregularly shaped tract of somewhat higher ground associated with Portage Bayou and Open Bay on the New Madrid-Pemiscot county line. Boundaries, based on county soil surveys, are drawn to enclose the coarser-textured soils of this landform.	The LTA is a natural levee or splay created by historic flows of the Mississippi River through the Portage/Open Bay distributaries leaving the main channel. (This route, with a short portage, served as a water connection for French rivermen between the St. Francis and Mississippi Rivers.) Local relief is 20–30 feet. The surface is slightly elevated and composed mainly of loamy, well-drained soils with clayey depressions. Historically, the LTA was bottomland forest and swamps in the depressions. Today, it is drained and virtually all cropland, except along the historic river channels.
MB4d Little River Clayey Lowland	The large LTA occupies a long, broad lowland extending down the center of the subsection from Cape Girardeau on the Mississippi River to the Arkansas state line. Boundaries, based on county soil surveys, are drawn to enclose the clay lowland. In the north, the LTA abuts against the Ozark Highland and Benton Hills.	The LTA is the former swampland that was the heart of the southeastern lowlands of Missouri. It was the former location of the Mississippi River before it took its present course through the bedrock south of Cape Girardeau. It is the lowest-lying land into which the channels of the various drainage district converge. Local relief is exceptionally low, almost never above 10 feet. Clay dominates surficial materials. Soils are naturally very poorly drained and minimally developed (inceptisols). Historically, the LTA was dominated by swamps and backwater sloughs with wet bottomland forest on elevated areas. The middle part of the LTA was the historic Little River Swamp into which the Castor and Whitewater Rivers emptied. Today, most of the LTA is in the Little River Drainage District and is conspicuous for its numerous parallel drainage ditches. The northern end is occupied by the Headwaters Diversion Channel that diverts water to the Mississippi River. Virtually the entire LTA has been ditched, drained, detimbered, and converted to cropland. Surface water is affected by agricultural runoff. Very little native vegetation remains. Hornersville Swamp on the Arkansas border is one of the few substantial tracts of native vegetation.

(table continued on pg. 194)

LANDTYPE ASSOCIATIONS IN THE MISSISSIPPI RIVER ALLUVIAL PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
MB4e Sikeston Prairie/Savanna Sand Ridge	The LTA occupies a long, narrow sand ridge extending from north of Sikeston in Scott County to New Madrid on the Mississippi River. Boundaries are drawn along the margins of this sand ridge.	The LTA consists of a flat alluvial terrace, known as the Sikeston Ridge, that rises sharply 10–20 feet above the adjacent lowlands. Sandy and loamy alluvium, probably deposited by the Ohio River, forms well-drained and well-developed soils. The terrace has no streams of any consequence. Historically, sand prairie, savanna, and woodland dominated this land with occasional wet depressions. Today this landscape, where not urbanized, is virtually all cropland. Historic Indian trails, nineteenth-century roads, and modern highways have taken advantage of the elevated surface. Sikeston and New Madrid lie on the terrace. There are no public lands of any consequence.
MB4f Blodgett Dissected Sand Plain	The LTA occupies a low terrace spreading south from the Benton Hills on the eastern flank of the Sikeston Ridge. Boundaries, taken from county soil surveys, are drawn on the basis of sandy soils lying at a lower elevation than the Sikeston Ridge.	The LTA consists of a slightly elevated sandy terrace with numerous linear lowlands formerly created by braided streams. Local relief averages 10–20 feet. Soils are mainly sandy and poorly developed entisols, intersected by linear, poorly drained depressions. Historically the LTA was extensive sand prairie, savanna, and woodland, interspersed with wet bottomland forest and swamp. Today it is virtually all cropland with several sand prairie remnants and frequent wet depressions. Almost one-fourth of all heritage records in the subsection occur here, including regionally endemic Illinois chorus frogs and sand prairie species. I-55 traverses the LTA from north to south.
MB4g East Prairie Prairie/Savanna Dissected Sand Plain	The LTA occupies a broad sand plain between Charleston and East Prairie in Mississippi County. Boundaries, based on county and regional soil surveys, are drawn to enclose the low-lying sand surface.	The LTA consists of a sandy, slightly dissected terrace slightly above the alluvial plain to the east. It was formed by sediments laid down by a braided Ohio River in late Pleistocene time. Local relief is 20 feet. Well-drained sandy soils are interrupted by low swales with poorly drained soils. Historically the LTA was an extensive sand prairie and savanna with bottomland forest in the wetter depressions. Today it is virtually all cropland. Numerous sand prairie species survive in cemeteries.
MB4h Circle Ditch Bayou Clayey Lowland	The LTA occupies a small clayey lowland extending southeast from the Benton Hills in Scott County. Boundaries, based on county and regional soil surveys, are drawn to include clayey soils not part of the present, active alluvial plain of the Mississippi River.	The very small LTA consists of a former channel of the Mississippi River, now a depositional area with clay soils. Local relief is 10–20 feet. Historically the LTA was wet bottomland forest and swamp with alluviated oxbows. Today it is drained and virtually all cropland. One substantial patch of remnant native vegetation occurs at Whitesell's Woods.
MB4i St. Johns Bayou Clayey Lowland	The LTA occupies a low, clayey lowland flanking the southeastern side of the Sikeston Ridge in New Madrid County. Boundaries, based on county and regional soil surveys, are drawn to enclose the tract of clay soils, but not part of the present, active alluvial plain of the Mississippi River.	The LTA consists of a low-lying, clayey, and poorly drained lowland, including partially filled-in oxbows, that is now extensively ditched and drained, although it is still subject to backwater flooding. Historically, it was very wet with marshes, swamps, and wet bottomland forest. Today, it is mainly cropland with native vegetation in the lowest, wettest areas.
MB4j St. James Bayou Clayey Lowland	The LTA occupies a broad, clayey lowland in Mississippi County between the current Mississippi River alluvial plain and the East Prairie sand plain. Boundaries, based largely on county and regional soil surveys, are drawn to enclose the clay soils and the lowland, excluding the current Mississippi River alluvial plain.	The LTA consists of a clay lowland, a former alluvial plain of the Mississippi River, with several old channels now called bayous. It is low, wet, and subject to frequent backwater flooding. Most of the LTA lies in the New Madrid Floodway, the area between the main Mississippi River levee and a secondary setback levee. During high flows on the Mississippi, the floodway may be inundated intentionally to prevent more serious flooding downstream. Historically, the LTA was in marshes, swamps, and wet bottomland forest. Today, it is drained and mainly cropland with native vegetation associated with the lowest, wettest areas. Ten Mile Pond Conservation Area and Big Oak Tree State Park are in this LTA.
MB4k Portageville Bayou Clayey Lowland	The LTA occupies clayey lowlands associated with the Portage/Open Bay Drainage on the Pemiscot–New Madrid county line. Boundaries, based on county and regional soil surveys, are drawn to enclose the fluvial landform.	The very small LTA consists of former stream channels or oxbows, probably distributaries of the main Mississippi channel, now filled in to form clayey and swampy land. Soils are mainly clayey and very poorly drained. Historically, the LTA was marshes, swamps, and wet bottomland forest. Today, it has been drained and is mainly cropland with native vegetation associated with drainage ditches.

LANDTYPE ASSOCIATIONS IN THE MISSISSIPPI RIVER ALLUVIAL PLAIN SUBSECTION	LOCATION AND BOUNDARIES	GENERAL DESCRIPTION
MB4l Mississippi River Holocene Alluvial Plain	The LTA occupies the Mississippi River channel and an alluvial plain of variable width along the river that stretches the length of the subsection, from the Benton Hills to the Arkansas state line. Boundaries are drawn to include the river and current alluvial plain. In places the main Mississippi River levee forms the western boundary.	The LTA consists of the Mississippi River channel and the alluvial plain formed and used by it during the last several hundred years. Local relief averages 20 feet but rises to 30 feet when constructed levees are considered. The LTA is a sandy and loamy plain and natural levees, and the portions outside constructed levees are continually reworked by river processes and include sandbars and other lands temporarily and seasonally above water level. The channel, formerly with shifting banks (as shown by the historic removal of the village of New Madrid from its original location and the avulsions that cut off two bends in eastern Mississippi County), has been stabilized, although the bed continues to change its configuration. Channel depth can reach more than 50 feet in bends below the Ohio River junction. Average discharge at Caruthersville is more than 500,000 cubic feet per second. Historically, the LTA was riverfront forest of cottonwood, silver maple, elm, ash, and hackberry, with occasional low wet swamps and bottomland forest. Today, lands protected by levees are ditched and drained and in cropland, but other areas are regularly subject to high waters and may still have remnant native vegetation. Donaldson Point and Seven Island Conservation Areas are representative of this LTA.

Jim Rathert

An extensive system of drainage ditches has drained most of the Mississippi River Alluvial Basin Section in Missouri, allowing its very productive cropland to be farmed.

Landtype Associations

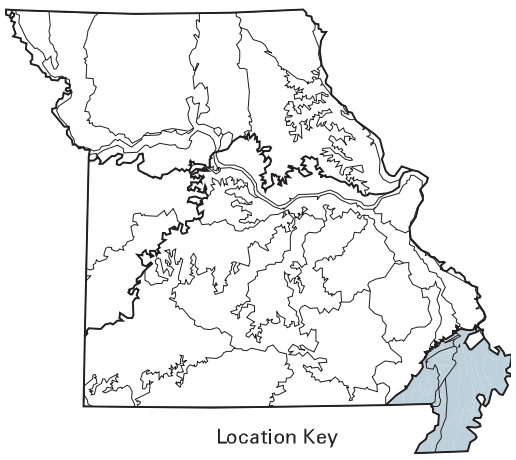
MB1 Black River Alluvial Plain Subsection
See text on pg. xx

MB2 Crowley's Ridge Subsection
See text on pg. xx

MB3 St. Francis River Alluvial Plain Subsection
See text on pg. xx

MB4 Mississippi River Alluvial Plain Subsection
See text on pg. xx

First Approximation—March, 2001



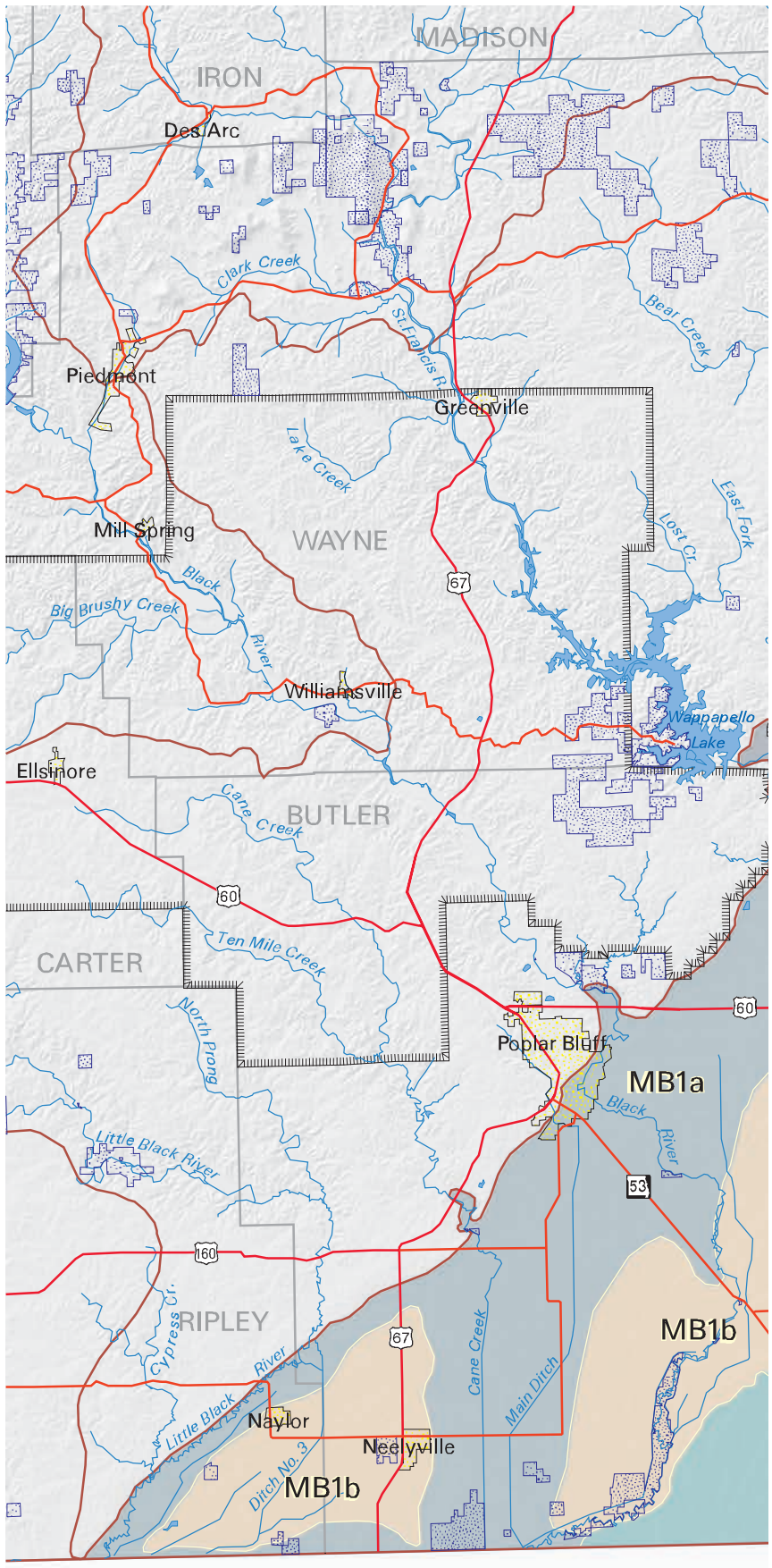
Black River Alluvial Plain Subsection
- MB1a Black River Silty Lowland
- MB1b Ash Hill Low Sand Hills and Terraces
- MB1c Otter Slough Silty Terrace
- MB1d Mingo Silty Lowland
- MB1e Castor River Silty Lowland
- MB1f Advance Sand Plain

Crowley's Ridge Subsection
- MB2a Crowley's Ridge Loess Woodland/Forest Hills
- MB2b Crowley's Ridge Footslopes and Alluvial Plains

St. Francis River Alluvial Plain Subsection
- MB3a St. Francis River Floodplain
- MB3b Campbell Dissected Silty Terrace
- MB3c Kennett-Malden Prairie/Savanna Dissected Sand Ridge
- MB3d Honey-Cypress Loamy Terrace

Mississippi River Alluvial Plain Subsection
- MB4a Parma Dissected Terrace
- MB4b Ash Slough Dissected Terrace
- MB4c Portageville Loamy Natural Levee
- MB4d Little River Clayey Lowland
- MB4e Sikeston Prairie/Savanna Sand Ridge
- MB4f Blodgett Dissected Sand Plain
- MB4g East Prairie Prairie/Savanna Sand Plain
- MB4h Circle Ditch Bayou Clayey Lowland
- MB4i St. Johns Bayou Clayey Lowland
- MB4j St. James Bayou Clayey Lowland
- MB4k Portageville Bayou Clayey Lowland
- MB4l Mississippi River Holocene Alluvial Plain

map continued on pgs. 178–179

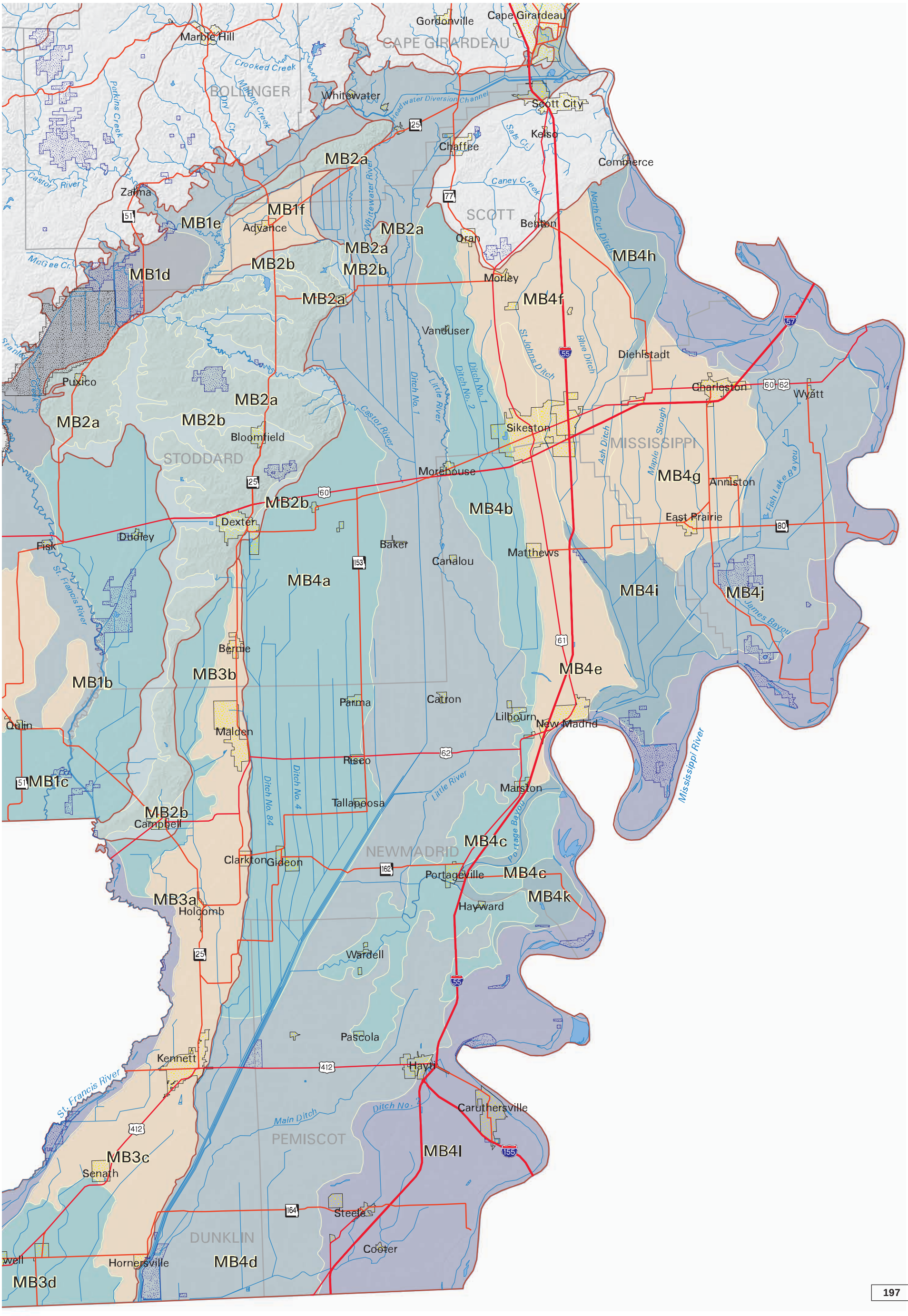


- Public Lands- Federal
- Public Lands - State
- County Boundaries
- Ecological Subsection Boundaries
- Major Roads
- US Forest Service Purchase Units

Map Scale 1:411,840 (1 inch = 6.5 miles)

0 5 10 15 20 mi
0 10 20 30 km

map continued on pgs. 176–179



Appendix: *A Comparison of Terrestrial Natural Community Nomenclatures*

To describe adequately the terrestrial natural communities associated with the ecological units, we created a hybrid nomenclature incorporating the National Vegetation Classification System developed by The Nature Conservancy and the 2002 revision of Nelson's *The Terrestrial Natural Communities of Missouri.* We believe these names combine the strengths of both systems in naming dominant vegetation as well as physical features.

Atlas of Missouri Ecoregions Terrestrial Natural Communities	*Terrestrial Natural Communities of Missouri* (Nelson, 2002) Natural Community Type (numbered) and Subtypes (lettered)	The Nature Conservancy Vegetation Classification Association—2001 (Synonym)	Comments
I. FOREST			
A. Loess/Glacial Till Forest			
	1. Dry-Mesic Loess/Glacial Till Forest		
Black Oak, White Oak–Hickory Dry-Mesic Glaciated Forest	a. Black Oak, White Oak, Hickory	Black Oak–White Oak–Hickory Forest	Drier sites on exposed south and west slopes and ridges.
White Oak–Hickory Dry-Mesic Glaciated Forest	*b.* White Oak, Hickory	White Oak–Hickory Forest	Protected slopes on base-rich deep loess/till soils. Nearly pure white oak.
Midwest White Oak–Red Oak Dry-Mesic Glaciated Forest	None	Midwest White Oak–Red Oak Forest	Protected slopes and coves; moist extreme of dry-mesic.
	2. Mesic Loess/Glacial Till Forest		
Red Oak, Sugar Maple, Elm Mesic Glaciated Forest	*a.* White Oak, Red Oak, Sugar Maple	Red Oak–Sugar Maple–Elm Forest	Upper north and east slopes.
Central Maple, Basswood Mesic Glaciated Forest	*b.* Maple, Basswood/Pawpaw	Central Maple-Basswood Forest	Very mesic coves, low slopes.
Beech, Oak, Tulip Tree Mesic Loess Forest (southeastern Mo.)	*c.* Beech, Oak, Tulip Poplar	Beech-Oak-Tuliptree Forest	Eastern mesophytic forest in southeastern Mo. Low slopes in coves.
B. Limestone/Dolomite Forest			
White Oak–Mixed Oak/Redbud Dry-Mesic Limestone/Dolomite Forest	*1. Dry-Mesic Limestone/Dolomite Forest*	White Oak–Mixed Oak/Redbud Dry-Mesic Alkaline Forest	
	2. Mesic Limestone/Dolomite Forest		
Red Oak, White Oak, Sugar Maple Mesic Limestone/Dolomite Forest	*a.* White Oak, Red Oak, Sugar Maple/ Spicebush	White Oak–Red Oak–Sugar Maple Mesic Forest	North and east slopes.
Maple-Basswood Mesic Limestone/ Dolomite Forest	*b.* Maple, Basswood/Pawpaw	Central Maple-Basswood Forest	Very mesic coves, low slopes.
C. Chert Forest			
	1. Dry-Mesic Chert Forest		
Mixed Oak–Hickory/Dogwood Dry-Mesic Chert Forest	*a.* Black Oak, White Oak, Hickory/ Dogwood	Oak-Hickory Dry-Mesic Acid Forest	Ultic soils (highly leached, base poor, quite acidic) on upper slopes and ridges.
Shortleaf Pine, White Oak Dry-Mesic Chert Forest	*b.* Shortleaf Pine, White Oak/Dogwood	Shortleaf Pine–White Oak Forest	Alfic soils on exposed slopes, benches, and ridges. This type on ultic soils is a woodland.
White Oak/Dogwood Dry-Mesic Chert Forest	*c.* White Oak, Red Oak/Dogwood	White Oak–Dogwood Dry-Mesic Forest	Alfic soils (base rich, ≥35% base saturation) on lower north and east slopes.

Atlas of Missouri Ecoregions Terrestrial Natural Communities	*Terrestrial Natural Communities of Missouri* (Nelson, 2002) Natural Community Type (numbered) and Subtypes (lettered)	The Nature Conservancy Vegetation Classification Association—2001 (Synonym)	Comments
D. Sandstone Forest			
	1. Dry-Mesic Sandstone Forest		
Mixed Oak–Hickory/Dogwood Dry-Mesic Sandstone Forest	*a.* Black Oak, White Oak, Hickory/Dogwood	Oak-Hickory Dry-Mesic Acid Forest	Ultic soils on upper slopes and ridges.
Shortleaf Pine, White Oak Dry-Mesic Sandstone Forest	*b.* Shortleaf Pine, White Oak/Dogwood	Shortleaf Pine–White Oak Forest	Alfic soils on exposed slopes, benches, and ridges. This type on ultic soils is a woodland.
Red Oak, White Oak, Sugar Maple Mesic Sandstone Forest	2. Mesic Sandstone Forest	White Oak–Red Oak–Sugar Maple Mesic Forest	
E. Igneous Forest			
	1. Dry-Mesic Igneous Forest		
Mixed Oak–Hickory/Dogwood Dry-Mesic Igneous Forest	*a.* Black Oak, White Oak, Hickory/Dogwood	Oak-Hickory Dry-Mesic Acid Forest	Lower exposed slopes.
White Oak/Dogwood Dry-Mesic Igneous Forest	*b.* White Oak, Red Oak/Dogwood	White Oak–Dogwood Dry-Mesic Forest	Lower north and east slopes.
F. Sand Forest			
None	*1. Dry-Mesic Sand Forest*	None	
Beech, Sugar Maple, Sweetgum Mesic Sand Forest (Crowley's Ridge)	*2. Mesic Sand Forest*	Beech-Maple-Sweetgum Sand Forest	
G. Bottomland Forest			
White Oak/Dogwood Dry-Mesic Bottomland Forest *(Note: type is similar to chert, igneous, and sandstone upland forest types)*	*1. Dry-Mesic Bottomland Forest*	Oak-Hickory Dry-Mesic Acid Forest White Oak–Dogwood Dry-Mesic Forest	
Red Oak, Sugar Maple, Bitternut Hickory Mesic Bottomland Forest	*2. Mesic Bottomland Forest*	Sugar Maple–Bitternut Hickory Mesic Bottomland Forest	
	3. Wet-Mesic Bottomland Forest		
Swamp Chestnut Oak–Sweetgum Wet-Mesic Bottomland Forest (southeastern Mo.)	*a.* Mississippi Lowlands—Swamp Chestnut Oak, Sweetgum	Swamp Chestnut Oak–Sweetgum Wet-Mesic Floodplain Forest	Higher floodplains and terraces.
Bur Oak, Swamp White Oak, Shellbark Wet-Mesic Bottomland Forest	*b.* North Missouri—Bur Oak, Swamp White Oak, Shellbark Hickory	Bur Oak–Swamp White Oak Mixed Bottomland Forest	Higher floodplains and terraces in Till and Osage Plains Sections, often with bur oak, swamp white oak, and shellbark hickory.
	4. Wet Bottomland Forest		
Pin Oak–Willow Oak/Deciduous Holly Wet Bottomland Forest (southeastern Mo.)	*a.* Mississippi Lowlands—Pin Oak, Willow Oak/Deciduous Holly	Overcup Oak–Pin Oak Forest	Backswamps, swales, and old oxbows in the Mississippi River Alluvial Basin Section.
Overcup Oak–Water Hickory (Sweetgum)/Swamp Privet Wet Bottomland Forest (southeastern Mo.)	*b.* Mississippi Lowlands—Overcup Oak, Water Hickory/Swamp Privet	Overcup Oak–Nuttall's Oak Bottomland Forest Overcup Oak–Sweetgum Forest	Backswamps, swales, and old oxbows in the Mississippi River Alluvial Basin Section. Slightly lower and wetter than the type above.
Red Maple, Water Locust, Plane Tree Wet Bottomland Forest (southeastern Mo.)	*c.* Mississippi Lowlands—Red Maple, Water Locust, Plane Tree	Red Maple–Water Locust Mixed Bottomland Forest	Nearly permanent inundation. Backswamps, swales, and old oxbows in the Mississippi River Alluvial Basin Section.
Pin Oak–Mixed Hardwood Wet Bottomland Forest	*d.* Pin Oak, Mixed Hardwood	Pin Oak Mixed Hardwood Forest	Backswamps, swales, and old oxbows on the big rivers in Till Plains, Osage Plains, and Ozark Highlands Sections.

Atlas of Missouri Ecoregions Terrestrial Natural Communities	*Terrestrial Natural Communities of Missouri* (Nelson, 2002) Natural Community Type (numbered) and Subtypes (lettered)	The Nature Conservancy Vegetation Classification Association—2001 (Synonym)	Comments
G. Bottomland Forest (cont.)			
	5. Riverfront Forest		
Sycamore, Cottonwood, Willow Riverfront Forest	*a.* Sycamore, Cottonwood, Black Willow	River Birch–Sycamore Forest Cottonwood–Black Willow Forest	More typical in Ozarks. Low, active floodplains on more sandy and gravelly soils.
Silver Maple, Elm, Cottonwood Riverfront Forest	*b.* Silver Maple, Green Ash, Elm	Silver Maple–Elm (Cottonwood) Forest Silver Maple–Sugarberry–Pecan Terrace Forest	More typical in big rivers in Till Plains, Osage Plains, and Ozark Highlands Sections. Low, active floodplains on more silty soils.
Green Ash, American Elm, Sugarberry Riverfront Forest	*c.* Elm, Ash, Hackberry, Oak	Southern Green Ash–Elm–Sugarberry Forest Ash-Oak-Sycamore Mesic Bottomland Forest	Higher, active floodplains on loamy soils.
II. WOODLAND			
A. Loess/Glacial Till Woodland			
	1. Dry Loess/Glacial Till Woodland		
Central Tallgrass Post Oak Dry Glaciated Woodland	*a.* Post Oak, Black Oak	Central Tallgrass Post Oak Woodland	Dominant woodland in more dissected hills landscapes.
Eastern Great Plains Bur Oak Dry Glaciated Woodland	*b.* Bur Oak, Chinkapin Oak	Eastern Great Plains Bur Oak Woodland	Dominant woodland in more rolling hills and plains landscapes. Northwest Missouri loess hills prairie landscape.
Central White Oak Dry-Mesic Glaciated Woodland	*2. Dry-Mesic Loess/Glacial Till Woodland*	White Oak Central Glaciated Woodland	Nearly pure white oak on till soils.
Northern Mixed Oak Dry-Mesic Glaciated Woodland		Northern Dry-Mesic Oak Woodland	More mixed oaks than above.
B. Limestone/Dolomite Woodland			
Chinquapin Oak–Ash (Eastern Red Cedar)/Little Bluestem Dry Limestone/ Dolomite Woodland	*1. Dry Limestone/Dolomite Woodland*	Ozark Ashe's Juniper Woodland Red Cedar Xeric Alkaline Woodland Chinquapin Oak–Ash/Little Bluestem Woodland	
Chinquapin Oak, White Oak, Red Oak, Sugar Maple/Redbud Dry-Mesic Limestone/Dolomite Woodland	*2. Dry-Mesic Limestone/Dolomite Woodland*	None	
C. Chert Woodland			
	1. Dry Chert Woodland		
Post Oak–Blackjack Oak/Bluestem Dry Chert Woodland	*a.* Post Oak, Blackjack Oak/Bluestem	Post Oak–Blackjack Oak/Little Bluestem Woodland	Shallow, droughty soils on exposed slopes and broad ridges. Often adjacent to glades with a good cover of warm-season grasses.
Post Oak, Black Oak, Scarlet Oak Dry Chert Woodland	*b.* Post Oak, Black Oak, Scarlet Oak/ Bluestem	Ozark Black Oak–Scarlet Oak Forest	Deeper soils than above on upper and midslopes, all aspects. Greater tree density than above. Typical in western Ozarks.
Shortleaf Pine/Bluestem Dry Chert Woodland	*c.* Shortleaf Pine/Bluestem	Shortleaf Pine/Little Bluestem Woodland	Upland divides and broad ridges, mainly on the Roubidoux formation.
Shortleaf Pine–Oak/Vaccinium Dry Chert Woodland	*d.* Shortleaf Pine, Oak/Blueberry	Shortleaf Pine–Oak Dry Woodland	Ridges and exposed slopes in dissected landscapes.

Atlas of Missouri Ecoregions Terrestrial Natural Communities	*Terrestrial Natural Communities of Missouri* (Nelson, 2002) Natural Community Type (numbered) and Subtypes (lettered)	The Nature Conservancy Vegetation Classification Association—2001 (Synonym)	Comments
C. Chert Woodland (cont.) *(Note types cross over into igneous and sandstone substrates)*			
	2. Dry-Mesic Chert Woodland		
Shortleaf Pine, White Oak Dry-Mesic Chert Woodland	*a.* Shortleaf Pine, Oak/Bluestem	Shortleaf Pine–Oak Dry-Mesic Woodland	Alfic soils on exposed slopes, benches, and ridges. This type is a forest in absence of fire.
White Oak–Black Oak Dry-Mesic Chert Woodland	*b.* White Oak, Black Oak/Bluestem	White Oak–Post Oak/Bluestem Woodland	Moderately deep soils on protected landscape positions. Typically with a good cover of sedges, goldenrods, and sunflowers.
D. Sandstone Woodland			
	1. Dry Sandstone Woodland		
Post Oak–Blackjack Oak/Bluestem Dry Sandstone Woodland	*a.* Post Oak, Blackjack Oak/Bluestem	Post Oak–Blackjack Oak/Little Bluestem Woodland	Shallow, droughty soils on exposed slopes and broad ridges. Often adjacent to glades with a good cover of warm-season grasses.
Post Oak, Black Oak, Scarlet Oak Dry Sandstone Woodland	*b.* Post Oak, Black Oak, Scarlet Oak/ Bluestem	Ozark Black Oak–Scarlet Oak Forest	Deeper soils than above on upper and midslopes, all aspects. Greater tree density than above. Typical in western Ozarks.
Shortleaf Pine/Bluestem Dry Sandstone Woodland	*c.* Shortleaf Pine/Bluestem	Shortleaf Pine/Little Bluestem Woodland	Upland divides and broad ridges, mainly on the Roubidoux formation.
Shortleaf Pine–Oak/Vaccinium Dry Sandstone Woodland	*d.* Shortleaf Pine, Oak/Blueberry	Shortleaf Pine–Oak Dry Woodland	Ridges and exposed slopes in dissected landscapes.
Shortleaf Pine, White Oak Dry-Mesic Sandstone Woodland	*2. Dry-Mesic Sandstone Woodland*	Shortleaf Pine–Oak Dry-Mesic Woodland	White Oak–Post Oak/Bluestem Woodland
E. Igneous Woodland			
	1. Dry Igneous Woodland		
Post Oak–Blackjack Oak/Bluestem Dry Igneous Woodland	*a.* Post Oak, Blackjack Oak/Bluestem	Post Oak–Blackjack Oak/Little Bluestem Woodland	Shallow, droughty soils on exposed slopes and broad ridges. Often adjacent to glades with a good cover of warm-season grasses.
Post Oak, Black Oak, Scarlet Oak Dry Igneous Woodland	None	Ozark Black Oak–Scarlet Oak Forest	Deeper soils than above on upper and midslopes, all aspects. Greater tree density than above. Typical in western Ozarks.
Shortleaf Pine–Oak/Vaccinium Dry Igneous Woodland	*b.* Shortleaf Pine, Oak/Blueberry	Shortleaf Pine–Oak Dry Woodland	Ridges and exposed slopes in dissected landscapes.
Shortleaf Pine, White Oak Dry-Mesic Igneous Woodland	*2. Dry-Mesic Igneous Woodland*	Shortleaf Pine–Oak Dry-Mesic Woodland	White Oak–Post Oak/Bluestem Woodland
F. Sand Woodland			
Post Oak, Blackjack Oak/Bluestem Dry Sand Woodland	*1. Dry Sand Woodland*	Post Oak–Blackjack Oak/Bluestem Sand Woodland Post Oak–Mixed Oak Sand Woodland	
None	*2. Dry-Mesic Sand Woodland*	None	

Atlas of Missouri Ecoregions Terrestrial Natural Communities	*Terrestrial Natural Communities of Missouri* (Nelson, 2002) Natural Community Type (numbered) and Subtypes (lettered)	The Nature Conservancy Vegetation Classification Association—2001 (Synonym)	Comments
G. Flatwoods			
Post Oak Flatwoods	*1. Upland Flatwoods*	Post Oak Flatwoods	Seasonally wet, high flats.
Pin Oak, Post Oak, Cherrybark Oak Lowland Flatwoods	*2. Bottomland Flatwoods*	Pin Oak–Post Oak Lowland Flatwoods	Southeastern Mo.
Sinkhole Pond Flatwoods	*3. Sinkhole Flatwoods*	Willow Oak Bottomland Forest	TNC type is a poor fit; multiple species can occur.
H. Bottomland Woodlands			
None	*1. Dry-Mesic Bottomland Woodland*	None	
None	*2. Mesic Bottomland Woodland*	None	
None	*3. Wet-Mesic Bottomland Woodland*	None	
Bur Oak, Swamp White Oak, Shellbark Hickory Mesic Bottomland Woodland	*a.* Bur Oak, Swamp White Oak, Shellbark Hickory	Bur Oak Bottomland Woodland	Higher floodplains and terraces near larger bottomland prairies.
Cottonwood Bottomland Woodland	*b.* Cottonwood, Willow	Cottonwood Floodplain Woodland	Lower floodplains directly adjacent to bottomland prairie and marsh.
III. SAVANNA			
A. Loess/Glacial Till Savanna			
Central Bur Oak Glaciated Dry-Mesic Savanna	*1. Dry-Mesic Loess/Glacial Till Savanna*	Central Bur Oak Glaciated Dry-Mesic Savanna	
None	*2. Mesic Loess/Glacial Till Savanna*	None	
B. Limestone/Dolomite Savanna			
None	*1. Dry-Mesic Limestone/Dolomite Savanna*	None	
C. Chert Savanna			
Central Post Oak Dry Barrens	*1. Dry-Mesic Chert Savanna*	Post Oak Central Dry Barrens	
D. Sandstone/Shale Savanna			
Post Oak Central Dry Barrens	*1. Dry-Mesic Sandstone/Shale*	Post Oak Central Dry Barrens	
E. Sand Savanna			
Post Oak–Mixed Oak Dry Sand Savanna	*1. Dry-Mesic Sand Savanna*	Post Oak–Mixed Oak Sand Woodland	
IV. PRAIRIE			
A. Loess/Glacial Till Prairie			
	1. Dry Loess/Glacial Till Prairie		
Loess Hills Dry Prairie	*a.* Upper Missouri—Blue Grama, Soapweed	Loess Hills Little Bluestem Dry Prairie	
Loess Hills Dry Prairie	*b.* Lower Missouri—Side Oats Grama, Pale Purple Coneflower	Loess Hills Little Bluestem Dry Prairie	
Midwest Dry-Mesic Glaciated Prairie	*2. Dry-Mesic Loess/Glacial Till Prairie*	Eastern Great Plains Big Bluestem Loess Prairie Midwest Dry-Mesic Prairie	
Central Mesic Tallgrass Glaciated Prairie	*3. Mesic Loess/Glacial Till Prairie*	Central Mesic Tallgrass Prairie	

Atlas of Missouri Ecoregions Terrestrial Natural Communities	*Terrestrial Natural Communities of Missouri* (Nelson, 2002) Natural Community Type (numbered) and Subtypes (lettered)	The Nature Conservancy Vegetation Classification Association—2001 (Synonym)	Comments
IV. PRAIRIE (cont.)			
B. Limestone/Dolomite Prairie			
Midwest Dry-Mesic Limestone/ Dolomite Prairie	*1. Dry-Mesic Limestone/Dolomite Prairie*	Midwest Dry-Mesic Limestone-Dolomite Prairie	
C. Chert Prairie			
Midwest Dry-Mesic Chert Prairie	*1. Dry-Mesic Chert Prairie*	Midwest Chert Prairie	
D. Sandstone/Shale Prairie			
Midwest Dry-Mesic Sandstone/Shale Prairie	*1. Dry-Mesic Sandstone/Shale Prairie*	Midwest Sandstone/Shale Prairie	
E. Sand Prairie			
	1. Dry Sand Prairie		
Midwest Dry Sand Prairie	*a.* North Missouri—Side Oats Grama, Yellow Puccoon	Midwest Dry Sand Prairie	Sandy terraces on high floodplains in the upper Mississippi River in the Till Plains Section.
Mississippi Embayment Sand Prairie	*b.* Mississippi Lowlands—Splitbeard Bluestem, Jointweed	Mississippi Embayment Sand Prairie	Sandy dunes and knolls in southeastern Mo.
Midwest Dry-Mesic Sand Prairie	*2. Dry-Mesic Sand Prairie*	Midwest Dry-Mesic Sand Prairie	Sandy terraces on high floodplains in the upper Mississippi River in the Till Plains Section.
F. Prairie Swale			
Unglaciated Mesic Prairie Swale	Prairie Swale	Unglaciated Mesic Tallgrass Prairie	
G. Hardpan Prairie			
Hardpan Prairie	Hardpan Prairie	Little Bluestem Hardpan Prairie	
H. Bottomland Prairie			
Central Wet-Mesic Tallgrass Prairie	*1. Wet-Mesic Bottomland Prairie*	Central Wet-Mesic Tallgrass Prairie	
Central Cordgrass Wet Prairie	*2. Wet Bottomland Prairie*	Central Cordgrass Wet Prairie	
V. GLADE			
Limestone/Shale Glade	Limestone/Shale Glade	Central Shale Glade Ozark Limestone Glade	
Dolomite Glade	Dolomite Glade	Ozark Dolomite Glade	
Chert Glade	Chert Glade	Ozark Chert Glade	
Sandstone Glade	Sandstone Glade	Ozark Sandstone Glade	
Igneous Glade	Igneous Glade	Ozark Igneous Glade Blackjack Oak Xeric Scrub	

Atlas of Missouri Ecoregions Terrestrial Natural Communities	*Terrestrial Natural Communities of Missouri* (Nelson, 2002) Natural Community Type (numbered) and Subtypes (lettered)	The Nature Conservancy Vegetation Classification Association—2001 (Synonym)	Comments
VI. CLIFF/TALUS			
A. Cliff			
	1. Limestone/Dolomite Cliff		
Midwest Dry Limestone/Dolomite Cliff	*a.* Dry Limestone/Dolomite Cliff	Midwest Dry Limestone/Dolostone Cliff	
Midwest Moist Limestone/Dolomite Cliff	*b.* Moist Limestone/Dolomite Cliff	Midwest Moist Limestone/Dolostone Cliff	
	2. Sandstone Cliff		
Midwest Dry Sandstone Cliff	*a.* Dry Sandstone Cliff	Midwest Sandstone Dry Cliff	
Midwest Moist Sandstone Cliff	*b.* Moist Sandstone Cliff	Midwest Sandstone Moist Cliff	
	3. Chert Cliff		
Ozark Dry Chert Cliff	*a.* Dry Chert Cliff	Ozark Dry Chert Cliff	
Ozark Moist Chert Cliff	*b.* Moist Chert Cliff	Ozark Moist Chert Cliff	
	4. Igneous Cliff		
Ozark Dry Igneous Cliff	*a.* Dry Igneous Cliff	Ozark Igneous Dry Cliff	
Ozark Moist Igneous Cliff	*b.* Moist Igneous Cliff	Ozark Moist Igneous Cliff	
B. Talus			
Limestone-Dolomite Talus	*1. Limestone/Dolomite Talus*	Limestone-Dolomite Talus	
Interior Highlands Igneous Talus	*2. Igneous Talus*	Interior Highlands Igneous Talus	
VII. Streamside Communities			
A. Sandbar			
Riverine Sand Flats	Sand Bar	Riverine Sand Flats	
B. Gravel Wash			
Gravel Wash	*a.* Witch Hazel, Ninebark	Witch Hazel–Dogwood Gravel Wash	Gravel and bedrock washes associated with streams prone to flash flooding.
Gravel Bar	*b.* Ward's Willow, Water Willow	Carolina Willow Shrubland	Gravel bars along edges of larger streams.
None	*c.* Blue Beech	Upland waterways.	
C. Stream or Riverbank/Riverfront			
None	*a.* Glaciated Plains/Big Rivers Stream Edge	None	
None	*b.* Prairie Stream Edge	None	
None	*c.* Ozark Stream Edge	None	
None	*d.* Mississippi Lowlands Stream Edge	None	

Atlas of Missouri Ecoregions Terrestrial Natural Communities	*Terrestrial Natural Communities of Missouri* (Nelson, 2002) Natural Community Type (numbered) and Subtypes (lettered)	The Nature Conservancy Vegetation Classification Association—2001 (Synonym)	Comments
VIII. WETLAND			
A. Riverine			
	1. Freshwater Marsh		
Midwest Water Lily, American Lotus Deep Marsh	*a.* Water Lily, American Lotus Deep Marsh	Central Water Lily Aquatic Wetland American Lotus Aquatic Wetland	Dominated by floating aquatic plants. Water typically >3 ft. deep. Water regime: permanently flooded and intermittently exposed.
Midwest Emergent Marsh	*b.* Bulrush, Cattail, Bur Reed Emergent Marsh	River Bulrush Marsh Bulrush–Cattail–Bur Reed Shallow Marsh Midwest Mixed Emergent Deep Marsh Midwest Cattail Deep Marsh	Dominated by emergent water-loving plants. Water usually 1–3 ft. deep. Water regime: semipermanently flooded.
Ephemeral Marsh/Sedge Meadow	*c.* Smartweed, Bur Marigold Ephemeral Wetland	Temporary Herbaceous Pond Sedge Meadow	Dominated by water-loving plants in shallow depressions and marsh edges. Often drying out by late summer. Water regime: seasonally flooded.
Buttonbush Shrub Swamp	*2. Shrub Swamp*	Northern Buttonbush Swamp Southern Buttonbush Swamp	
Cypress, Tupelo Swamp	3. Swamp	Water Tupelo Swamp Bald Cypress–(Water Tupelo) Swamp Bald Cypress Swamp	
B. Sinkhole/Depressional Wetlands			
Sinkhole Pond Marsh	*1. Pond Marsh*	Sinkhole Pond Marsh	
Sinkhole Pond Shrub Swamp	*2. Pond Shrub Swamp*	Buttonbush Sinkhole Pond Swamp	
Sinkhole Pond Swamp	*3. Pond Swamp*	Water Tupelo Sinkhole Pond Swamp	
C. Ground Water Seepage			
	1. Ozark Fen		
Ozark Marl Fen	*a.* Marly	Ozark Fen	Soil <1 ft. with common gravel and marl deposits. Open areas.
Ozark Deep Muck Fen	*b.* Mucky	Ozark Deep Muck Fen	Soil >1 ft. with peat and muck. Completely vegetated and often shrub covered.
Ozark Prairie Fen	*2. Prairie Fen*	Ozark Prairie Fen	
Ozark Forested Fen	*3. Forested Fen*	Red Maple Forested Fen	
Glacial Fen	*4. Glacial Fen*	Great Plains Fen	
Acid Seep	*5. Acid Seep*	Midwest Acid Seep	
Saline Seep	6. Saline Seep	Eastern Great Plains Saline Marsh	
D. Groundwater Springs			
(Aquatic Classification system)	*1. Limestone/Dolomite Spring*	None	

Glossary

accretion gley. A bluish gray or olive gray soil that is sticky, compact, and often structureless, and is developed under the influence of excessive moisture

aggradation. The raising of a stream channel or floodplain surface over long periods of time when deposition exceeds erosion

alfisols. Soils with high base status and a clay-rich (argillic) B horizon; associated with tree vegetation

alluvial plain. A surface of low relief on alluvium or material deposited by streams, which may or may not be subject to flooding; often called a *floodplain* when subject to flooding

alluvium. Any stream-laid deposit whether in a channel or on an alluvial plain

anticline. Upfold of strata into an archlike structure; in Missouri, the best example of an anticline affecting topography is the Lincoln Fold

argillic horizon. Subsurface soil horizon in which clay minerals have accumulated; dense and impedes water movement in the soil

artesian. Condition in which water under hydraulic pressure rises in a well above the surrounding static water table and may reach the surface

avulsion. Sudden change in the location of a river channel as when a river cuts off a meander loop during a flood

backflooding. Flooding caused by rising river water that backs up and elevates the level of water in tributary streams or that floods the lower ends of river bottoms before the upper ends

backslope. The steepest inclined surface of a landscape between ridges and footslopes; includes linear sideslope, convex noseslope, and concave headslope components

bald. A treeless knob or narrow ridge, prominent in the landscape of the White River region of the Ozarks

barrens. A landscape of grasses, shrubs, and bushes, with few or no trees, often in a stony or droughty location; *barrens* was historically sometimes used synonymously in Missouri with *prairie* or thinly treed savanna

base flow. The portion of stream discharge that is contributed by groundwater seepage (including flowing springs); it is contrasted to quickflow or surface-water flow, which is water flowing over the land surface into the channel during periods of runoff

base level. The lowest elevation that can be attained by a stream; hence, the lowest elevation to which a stream can erode a surface

bases. Positively charged ions in the soils, which are often plant nutrients; of these, the most important are calcium, magnesium, sodium, and potassium

bedload. The coarser portion of the sediment transported by a stream (usually sands and gravels) that moves along the channel bed, as opposed to *suspended load,* the finer portion that moves within the water mass

bedrock. The solid rock that underlies unconsolidated earth materials; appears at the surface as outcrops

bench. An intermediate erosional level on valley sides caused either by a resistant stratum or by a pause in the regional uplift of the land during a sustained period of stream downcutting; in Missouri, benches, or *straths,* are common along the lower Missouri, the lower Osage, the lower Gasconade, and the White Rivers; the general topography is called *benchlands*

berm. A man-made low levee or dam constructed to hold water; in Missouri, many natural sinkhole ponds have berms created to hold deeper water

B horizon. See *subsoil*

blue hole. An especially deep depression on an alluvial plain, created by concentrated river scouring during floods; these are often formed on the lee sides of a levee breech, hence the alternate spelling, *blew hole*

blufflands. A belt of hills adjacent to major river valleys; in Missouri, these are generally timbered, loess-capped, and deeply ravined and include numerous Indian sites

bottoms; bottomland. The low-lying land along a river; usually used to refer to specific portions of an *alluvial plain* or *floodplain,* as the Bois Brule Bottom

breaks. The rugged topography, usually along a major river, distinguished by being adjacent to an upland of low relief; an upland is said "to break off" abruptly into a belt of higher-relief hills along the river

Cambrian. The earliest geologic period of the Paleozoic Era, 505–570 million years ago; in Missouri, Cambrian rock formations are chiefly dolomite and sandstone and include most notably the Eminence, Potosi, Bonne Terre, and Lamotte Formations

carbonate rock. Any limestone (calcium carbonate) or dolomite (calcium magnesium carbonate) rock, both of which are soluble

cave. A natural underground chamber with an opening to the surface; common in the karst landscapes of the Ozarks

chert. A rock that closely resembles flint and consists primarily of chalcedony (quartz) with smaller amounts of other quartz and silica; it is considered insoluble, unlike the carbonate rocks with which it usually occurs in Missouri

claypan. The dense, clay-rich (argillic) B horizon of soils that impedes water movement

colluvium. A sediment deposit at the base of a slope caused by sheet and rill erosion on the slope; in Missouri, loess has commonly washed downslope and accumulated as a *colluvial deposit*

cuesta. A landform developed on resistant strata having a low dip; it takes the form of an asymmetrical belt of low hills, with one side being noticeably steeper (the *scarp* or *escarpment*) than the other (the *backslope*)

Devonian. A geologic period of the Paleozoic Era, 360–408 million years ago; in Missouri, Devonian rock formations are usually limestone but are not widespread

distributary. A channel that leaves a river and reaches a body of water at a different location

dolomite. A sedimentary rock composed of calcium magnesium carbonate; it is soluble throughout Missouri and is associated with karst topography

drift. Any and all depositional materials related to glaciers, including ice-laid till and glaciofluvial and glacial-lake sediments

dune. A hill of sand shaped by wind; dunes are present in southeastern Missouri

ecoregion. A large (one to tens of thousands of square miles) geographic area having distinctive physical and biological attributes; a mosaic of distinctive landscapes

ecosystem. A group of organisms interacting with each other and their environment; ecosystems can be considered at multiple spatial scales

edge. A boundary between two distinct entities; mainly used to recognize boundaries between vegetation units like grassland and forest

effluent. The condition in which water is contributed to a system; an *effluent stream* receives water from groundwater sources, including seepage and springs

endangered. Federal and state listing status for describing any species that is in danger of extinction throughout all or a significant portion of its range

endemic. Describes a species or geologic feature whose distribution is confined to a particular geographic locality

entisols. Mineral soils lacking distinct horizons or having minimal soil development

eolian. Refers to the geomorphic process of transporting material by wind

ephemeral stream. A stream that lacks base flow and therefore flows only in response to surface-water runoff during periods of rainfall

escarpment. *See scarp*

federal-listed. Describes a species on the official list of threatened or endangered species in the United States

fen. A perennially saturated, swampy meadow fed by cool, mineral-rich springwater

fines. Any fine-sized sediments (usually clays and silts) in streams or soils

flatwoods. A timbered community of short, gnarly trees (in Missouri, often post, blackjack, or black oak) on flat landscapes with seasonal ponding on soils with fragipans

floodplain. A belt of low land along a stream channel, formed on alluvium and subject to floods of some reasonable frequency. Because many floodplains of major Missouri rivers are now protected from most floods, the more encompassing term *alluvial plain,* which includes other alluvial lands such as terraces, which are not subject to flooding, is preferred in this atlas

fluvial. Refers to geomorphic processes in which running water is the dominant agent shaping a surface, especially the channeled water of streams

forest. A vegetation community with a well-developed, closed canopy of trees, multitiered structure, and a ground flora dominated by shade-tolerant species

fragipan. A dense subsurface soil horizon that appears cemented and allows little water or root penetration; it is often 15–30 inches below the surface

glade. A natural, grassy opening in a woods or forest; in Missouri, glades are usually located on hillsides and are caused by rock or soil conditions

glaciofluvial Pertaining to streams carrying water from melting glaciers

headslope. The concave upper backslope at the top of a stream drainage

heritage record. A record in the Natural Heritage Database (located at the Missouri Department of Conservation in Jefferson City) detailing the identity and location of a state-listed species

Holocene. The geologic epoch comprising the last 10,000 years of earth history, beginning generally when the last continental ice sheet retreated from the conterminous United States

Illinoisan glaciation. The Pleistocene glaciation that preceded the last major glaciation, the Wisconsinan; Illinoisan glaciation entered Missouri only in the St. Louis region

inceptisols. Soils with weakly developed horizons (usually because the soil is young)

inflooding. The condition in which water temporarily lies on the land from excessive rains falling on it, as opposed to *outflooding,* when water spills out of a river channel onto the land

interfluve. A high, often flat to rolling surface of land along the drainage divide between two or more river valleys

intermittent stream. A stream that receives base flow from higher water tables during the wetter part of the year but has no base flow during the drier part of the year; thus, the stream flows only seasonally

interscarp plains. Plains of low relief that lie between escarpments (scarps) or belts of higher relief; in Missouri, interscarp plains are confined to the Osage Plains Subsection

karst. A topography dominated by processes and features of limestone or dolomite solution; common features include caves, sinkholes, springs, and losing streams

knob. An isolated peak with a broad, rounded, dome-shaped, or flattish summit; in Missouri, knobs are most common in the St. Francois region

landscape. In general, the assemblage of visible features of a restricted area; in this atlas, a small unit (tens to hundreds of square miles) of the U.S. Forest Service hierarchical system of ecological units characterized by local patterns in topography, geology, and vegetation

lek polygyny. The mating system of a species (in Missouri, most notably prairie chickens) in which a group of males gather in a particular area to perform courtship displays and compete for mating opportunities

levee. A raised barrier, generally earthen, along rivers that protects alluvial plains against flooding; alluvial rivers create their own, low *natural levees* from sediment deposited when water spills out of a channel

limestone forest. A forest growing on limestone parent materials

lithology. The character of a rock formation, such as "shale," "cherty limestone," and "granite"

loam. A soil characterized by a texture in which no one of the three texture sizes (clay, silt, sand) dominates

local relief. The difference between high and low elevations in the landscape; in Missouri, generally within one of two miles, or between a perennial stream valley and an adjacent major ridge

loess. The accumulation of fine-grained sediment (usually silt) on upland surfaces after being transported by wind; *redeposited loess* has subsequently been washed into lower elevations as colluvium or alluvium

losing stream. A stream that loses some or all of its surface flow to subsurface flow, so that the volume of water in the channel declines in a downstream direction; surface water thus lost may reappear in the channel farther downstream or in the channel of a different stream

mesic. Relatively moist; often used to describe landscapes capable of supporting vegetation *(mesophytes)* requiring an adequate moisture supply

mesophyte. A plant that inhabits moist environments

microclimate. The climate of a specific, relatively small site, such as a sinkhole, a forest floor (as opposed to the atmosphere above the tree canopy), or the base of a slope (as opposed to the top of the slope); sometimes called *topoclimate*

Mississippian. A geologic period of the Paleozoic Era, 320–360 million years ago; in Missouri, Mississippian rock formations are chiefly limestones and include most notably the Burlington Formation

mollisols. Soils with a thick, dark-colored surface soil horizon that contains large amounts of organic matter; associated with prairie vegetation

monadnock. Conspicuous, isolated hill that rises above a surrounding surface that was lowered by geologic erosion

native. A species that has inhabited a particular geographic area for a reasonably long period of time

nonnative. A species that has been introduced into a particular geographic area in relatively recent times

Ordovician. A geologic period of the Paleozoic Era, 438–505 million years ago; in Missouri, Ordovician rock formations are chiefly cherty dolomites with sandstones and limestones and include most notably the Gasconade, Jefferson City–Cotter, Roubidoux, and St. Peter Formations

outcrop. A surface exposure of bedrock, generally occurring on hillslopes as ledges or cliffs

outlier. An isolated hill that lies away from the general belt of hills of an escarpment

oxbow lake. A crescent lake on an alluvial plain that represents a former river channel abandoned when a river meander was cut off

paleosol. A soil that has been subsequently covered by glacial, eolian, or fluvial deposits; in Missouri, these generally are soils developed and buried during changing conditions during Pleistocene glaciations and interglacial periods

Paleozoic. A broad geologic era, 245–570 million years ago; subdivided into periods, which in Missouri are chiefly the Cambrian, Ordovician, Mississippian, and Pennsylvanian; the vast majority of substrate (bedrock) in Missouri is from the Paleozoic Era

pans. Broad, shallow depressions, sometimes miles across, in karst topography, created by the pervasive solution of carbonate bedrock; pans may hold water temporarily during wet periods and have marsh vegetation; more completely called *solution pans*

pedisediment. Glacial till that has been moved and reworked to lower elevations by gravitational or fluvial processes

pedological processes. Soil processes, especially those that form soil

Pennsylvanian. A geologic period of the Paleozoic Era, 285–320 years ago; in Missouri, Pennsylvanian formations are chiefly alternating series of shales, limestones, and sandstones

plains. A flat to gently rolling surface of generally less than 100 feet of local relief, but with some dissected plains having up to 150 feet of local relief; plains may support any type of vegetative cover

Pleistocene. A geologic epoch, generally the last 2 million years of earth history, but excluding the most recent 10,000 years; characterized by multiple glaciations, although glaciations began earlier in the Pliocene Epoch, 3.5 million years ago; also often called the *Quaternary Period* and the *Great Ice Age*

potential natural vegetation. The vegetative cover expected to return to an area if humans and their activities were removed

prairie. A plant-formation class consisting primarily of grasses but with broad-leaved flowering plants and, in Missouri, considerable woody "brush" but rarely trees of notable size; Missouri has mostly tallgrass prairie, dominated by little and big bluestem and Indian grass

Precambrian. Refers to all geologic time before the Paleozoic Era, thus anything older than 570 million years; in Missouri, Precambrian rock formations consist of igneous rocks, especially granite and rhyolite

pre-Illinoisan. Refers to the early glaciations of the Pleistocene Epoch; pre-Illinoisan glaciations (formerly subdivided into Kansan and Nebraskan glaciations) covered major parts of northern Missouri

presettlement. The time preceding the initial occupation of the land by Euro-Americans, which had longstanding and widespread impact on the environment; in Missouri, the beginning of Euro-American settlement ranges from the late 1700s along the Mississippi River to the 1840s in portions of the south-central Ozarks

Quaternary. See *Pleistocene*

rare. Describes an uncommon species that is likely to become endangered within the foreseeable future

reach. Any specific segment of a river channel, as in "the reach of the Missouri River between Arrow Rock and Boonville"

relief. The difference in elevation between low and high points in the landscape; relief is usually measured as *local relief,* the elevational difference between a perennial stream valley and an adjacent major ridge, or within one or two miles

residuum. Decomposed and disintegrated rock fragments and sediment derived from the bedrock beneath it, and not including the soil above it

rilling. A form of accelerated erosion in which numerous closely spaced, tiny channels *(rills)* form on an exposed soil surface

savanna. A vegetation community consisting of grasses and widely spaced trees with 10–20 percent canopy closure; in Missouri, savannas are generally sparsely timbered areas associated with prairies

scarp; escarpment. Any noticeable break of slope in regional topography; in Missouri, most scarps are the result of erosion, as cliffs and bluffs along rivers, but these are not generally called scarps in Missouri; other scarps are the steep slopes, with rock outcrops, along structures called *cuestas,* in landscapes thus called *scarplands* or *scarp hills;* still other scarps are caused by a vertical displacement along fault lines, and such features in southeastern Missouri are called *fault scarps*

second-growth forest. A forest that has developed after a previous forest had been cut or otherwise destroyed within the last one hundred years

Silurian. A geologic period of the Paleozoic Era, 408–438 million years ago; in Missouri, Silurian rock formations are not widespread

sink; sinkhole. A surface depression resulting from the solution of underlying carbonate bedrock and possibly also a collapse into an underground cavern; sinkholes are a major feature of karst topography in Missouri

slump block. A form of downslope movement on a hillside in which a block of earthen material slides on a curving plane of failure; slump blocking is common on steep hillsides, especially when fine residuum and soil are water saturated

soil order. The highest level of soil classification of the U.S. Natural Resources and Conservation Service; examples include *mollisols, ultisols,* and *entisols*

soil series. The soil types commonly used in mapping of county soils in Missouri and elsewhere; examples include the Knox, Goss, and Wabash soil series

splay. The spreading outward of water and sediments from a breach in a natural or man-made river levee

state-listed. Describes a species on Missouri's official list of species of conservation concern

strath. See *bench*

strike valley. A linear valley developed on less resistant rock that lies between two linear cuestas; its orientation is perpendicular to the regional dip of the strata

subsoil. The soil beneath the topsoil; generally called the *B horizon;* in many places, erosional removal of topsoil has resulted in subsoil positioned at the surface of the land

sunklands. Lands in southeastern Missouri thought to have subsided during the New Madrid earthquakes of 1811–1812; generally they are waterlogged or otherwise poorly drained

surficial materials. Earth materials, not including soil, that occur at the land surface, including loess, alluvium, glacial till, and various kinds of residuum

suspended load. The finer portion of sediment (clays and silts) transported by a stream; this sediment moves by turbulent suspension in the water mass and resists deposition as long as the water is in motion, as opposed to *bedload,* which moves on the bottom of the channel

swale. A shallow, linear depression in the landscape, such as those that form over filled-in chutes on alluvial plains or in the concave areas between dunes

Tertiary. A geologic period of the Cenozoic Era; 2–66 million years ago; in Missouri, Tertiary rock formations are represented by sandstone and shale on Crowley's Ridge

threatened. A federal listing status describing a species likely to become endangered in the foreseeable future throughout all or a significant portion of its range

till. An unstratified mixture of material (in Missouri, dominated by clay) deposited beneath moving glacial ice or from the melting of stagnant glacial ice; a smooth, low-relief land surface underlain by till is a *till plain*

toe slope. A concave bottom of a hillslope usually composed of colluvium washed down from higher portions of the slope

ultisols. Soils with warm soil temperatures, a clay-rich (argillic) B horizon, and a low base status; common in the Ozarks of Missouri

Wisconsinan. The last stage of several Pleistocene glaciations, which reached a peak about 18,000 years ago; Wisconsin glaciation did not reach Missouri, but major effects of glaciation were experienced

woodland; woods. A vegetation community with trees spaced to form an open canopy of 20–80 percent, little understory development, and a dense ground flora of sun-loving species, including grasses

Bibliography

Albert, D. A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: A working map and classification. General Technical Report NC-178. St. Paul, Minn.: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station.

Allgood, F. P., and I. D. Persinger. 1979. Missouri general soil map and soil association descriptions. Columbia: U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Missouri Agricultural Experiment Station.

Anderson, K. H., coordinator. 1979. Geologic map of Missouri. Map at 1:500,000. Rolla: Missouri Department of Natural Resources, Division of Geology and Land Survey.

The astronomical almanac for the year 1995. 1993. Washington, D.C.: U.S. Naval Observatory, Nautical Almanac Office.

Avers, P. E. 1993. Ecological classification, mapping, and integrated inventory task team, ECOMAP. In Integrated ecological and resource inventories: Proceedings of a national workshop, Phoenix, Arizona, April 12–16, 1993, ed. H. G. Lund, 8–15. Washington, D.C.: U.S. Department of Agriculture, Forest Service.

Avers, P. E., D. T. Cleland, W. H. McNab, M. E. Jensen, R. G. Bailey, T. King, C. B. Goudey, and W. E. Russell. 1994. The national hierarchical framework of ecological units. ECOMAP, USDA Forest Service, Washington, D.C.

Bailey, R. G. 1983. Delineation of ecosystem regions. Environmental Management 7:365–73.

———. 1985. The factor of scale in ecosystem mapping. Environmental Management 9:271–76.

———. 1988. Ecogeographic analysis: A guide to the ecological division of land for resource management. Miscellaneous Publication 1465. Washington, D.C.: U.S. Department of Agriculture.

———. 1989. Explanatory supplement to ecoregions map of the continents. With map at 1:30,000,000. Environmental Conservation 16:307–9.

———. 1995. Description of the ecoregions of the United States. 2d rev. ed. (1st ed., 1980). Miscellaneous Publication 1391 (rev.), with map at 1:7,500,000. Washington, D.C.: U.S. Department of Agriculture, Forest Service.

———. 1996. Ecosystem geography. New York: Springer-Verlag.

Bailey, R. G., P. Avers, T. King, W. H. McNab, eds. 1994. Ecoregions and subregions of the United States. Supplementary table comp. and ed. by W. H. McNab and R. G. Bailey. Map at 1:7,500,000. Washington, D.C.: U.S. Department of Agriculture, Forest Service.

Barnes, B., K. Pregitzer, A. Spies, and V. Spooner. 1982. Ecological forest site classification. Journal of Forestry 80:493–99.

Batek, M. J. 1994. Presettlement vegetation of the Current River watershed in the Missouri Ozarks. Master's thesis, University of Missouri–Columbia.

Bay, D. M., and R. P. Bellinghausen. 1979. Missouri crops and weather, 1969–78. Columbia: Missouri Crop and Livestock Reporting Service, Missouri Department of Agriculture.

Brackenridge, H. M. 1814. Views of Louisiana, together with a journal of a voyage up the Missouri River in 1811. Pittsburgh: Cramer, Spear, and Eichenbaum.

Branhan, R. L. 1974. Taming the mighty Missouri: A history of the Kansas City District Corps of Engineers, 1907–1971. Kansas City, Mo.: U.S. Army Corps of Engineers, Kansas City District.

Bryce, S. A., J. M. Omernik, D. E. Pater, M. Ulmer, J. Schaar, J. Freeouf, R. Johnson, P. Kuck, and S. H. Azvedo. 1998. Ecoregions of North Dakota and South Dakota. Map poster at 1:1,500,000. Reston, Va.: U.S. Geological Survey.

Chapman, S. S., J. M. Omernik, J. A. Freeouf, D. G. Huggins, J. R. McCauley, C. C. Freeman, G. Steinauer, R. T. Angelo, and R. L. Schlepp. 2000. Ecoregions of Nebraska and Kansas. Map poster at 1:1,950,000. Reston, Va.: U.S. Geological Survey.

Chapman, S. S., J. M. Omernik, G. E. Griffith, T. Nigh, W. A. Schroeder, and T. F. Wilton. 2002. Ecological regions of Iowa and Missouri. Map poster at 1:1,800,000. Reston, Va.: U.S. Geological Survey.

Collier, J. E. 1955. Geographic regions of Missouri. Annals of the Association of American Geographers 45:368–92.

Cozzens, A. B. 1937. The natural regions of the Ozark province. Ph.D. diss., Washington University, St. Louis.

———. 1939. Analyzing and mapping natural landscape factors of the Ozarks province. Transactions of the Academy of Science of St. Louis 30 (2): 37–63.

———. 1940. Physical profiles of the Ozark province. American Midland Naturalist 24:477–489.

Darkow, G. L. n.d. Drought probabilities in Missouri. Unpublished paper, Department of Soil and Atmospheric Sciences, University of Missouri–Columbia.

Decker, W. L. n.d. Late spring freezes in Missouri. Unpublished paper, Department of Soil and Atmospheric Sciences, University of Missouri–Columbia.

Delcourt, H. R., P. A. Delcourt, G. R. Wilkins, and E. N. Smith. 1986. Vegetational history of cedar glades regions in Tennessee, Kentucky, and Missouri during the past 30,000 years. ASB [Association of Southeastern Biologists] Bulletin 33 (4): 128–37.

Duden, G. 1829. Report on a journey to the western states of North America and a stay of several years along the Missouri. Gen. ed., James W. Goodrich; trans. and ed. George H. Kellner, Elsa Nagel, Adolf E. Schroeder, and W. M. Senner. Columbia: State Historical Society of Missouri and the University of Missouri Press, 1980.

Duley, J. W. 1983. Karst areas of Missouri. Map at approx. 1:1,000,000. In Geologic aspects of individual home liquid-waste disposal in Missouri, by J. W. Duley, plate 2. Engineering Geology Report no. 7. Rolla: Missouri Department of Natural Resources, Division of Geology and Land Survey.

Emerson, F. V. 1912. Geography of Missouri. Columbia: University of Missouri Bulletin, Educational Series vol. 1, no. 4.

Faber-Langendoen, D., ed. 2001. Plant communities of the Midwest: Classification in an ecological context. Arlington, Va.: Association for Biodiversity Information in Cooperation with The Nature Conservancy.

Fenneman, N. M. 1928. Physiographic divisions of the United States. 3d rev. With map at 1:7,000,000. Annals of the Association of American Geographers 18:261–353. Reprinted in The National Atlas of the United States (Washington, D.C.: U.S. Geological Survey, 1985), p. 60.

———. 1931. Physiography of the western United States. New York: McGraw-Hill.

———. 1938. Physiography of the eastern United States. New York: McGraw-Hill.

Foti, T. 1974. Natural divisions of Arkansas. In Arkansas natural area plan. Little Rock: Arkansas Department of Planning.

Giessman, N., T. Barney, T. Haithcoat, J. Meyers, and B. Massengale. 1986. Distribution of forest land in Missouri. Transactions of the Missouri Academy of Science 20:5–14.

Golley, F. B. 1993. A history of the ecosystem concept in ecology. New Haven: Yale University Press.

Griffith, G. E., J. M. Omernik, and S. H. Azvedo. 1998. Ecoregions of Tennessee. Map poster at 1:940,000. Reston, Va.: U.S. Geological Survey.

Griffith, G. E., J. M. Omernik, T. F. Wilton, and S. M. Pierson. 1994. Ecoregions and subregions of Iowa: A framework for water quality assessment and management. Journal of the Iowa Academy of Science 101:5–13.

Griffith, G. E., J. M. Omernik, and A. J. Woods. 1999. Ecoregions, watersheds, basins, and HUCs: How state and federal agencies frame water quality. Journal of Soil and Water Conservation 54:666–77.

Guyette, R. P., and E. A. McGinnes. 1983. Fire history of an Ozark glade from tree rings. Transactions of the Missouri Academy of Science 16:85–93.

———. 1991. Tree ring analysis of fire history of a post oak savanna in the Missouri Ozarks. Natural Areas Journal 11 (2): 93–99.

Hall, J. W. 1963. Lithology of Missouri south of the Missouri River. Master's thesis, Southern Illinois University, Carbondale.

Hammond, E. H. 1958. Procedures in the descriptive analysis of terrain. Washington, D.C.: Office of Naval Research (ONR) project no. NR 387–015. Contract no. Nonr-1202(01). Unpublished.

———. 1964. Analysis of properties in land form geography: An application to broad-scale land form mapping. Map supplement no. 4, with map at 1:5,000,000. Annals of the Association of American Geographers 54:11–23. Reprinted in The National Atlas of the United States (Washington, D.C.: U.S. Geological Survey, 1985), p. 61, with map at 1:17,000,000.

Hauck, H. S., L. G. Huber, and C. D. Nagel. 1997. Water resources data, Missouri: Water year 1996. Rolla, Mo.: U.S. Geological Survey Water-Data Report MO-96-1.

Hole, F. D., and C. E. Germain. 1994. Natural divisions of Wisconsin. Wisconsin Department of Natural Resources, Madison, Wisconsin.

Houck, L. 1908. A history of Missouri, from the earliest explorations and settlements until the admission of the state into the union. 3 vols. Chicago: R. R. Donnelley and Sons.

Howe, W. B., (coordinator), and J. W. Koenig (editor). 1961. The stratigraphic succession in Missouri. Missouri Division of Geological Survey and Water Resources. 2d Series, vol. 40. Rolla, Mo.

Huff, F. A., and J. R. Angel. 1992. Rainfall frequency atlas of the Midwest. Champaign, Ill.: Illinois State Water Survey, Bulletin 71.

Huff, F. A., and S. A. Changnon Jr. 1972. Climatological assessment of urban effects on precipitation at St. Louis. Journal of Applied Meteorology 11:823–42.

Jennings, M. D. 1993. Natural terrestrial cover classification: Assumptions and definitions. GAP Analysis Technical Bulletin 2. Moscow, Idaho: U.S. Fish and Wildlife Service, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho.

Keys, J. E., Jr., C. A. Carpenter, S. L. Hooks, F. G. Koenig, W. H. McNab, W. E. Russell, and M. L. Smith. 1995. Ecological units of the eastern United States: First approximation. Map at 1:3,500,000; includes booklet of map unit tables. J. E. Keys Jr., W. H. McNab, and C. A. Carpenter, eds. Atlanta: U.S. Department of Agriculture, Forest Service, Technical Publication R8-TP 21.

Kramer, K., R. Thom, G. Iffrig, K. McCarty, and D. Moore. 1996. Directory of Missouri Natural Areas. Jefferson City: Missouri Natural Areas Committee.

Krusekopf, H. H. 1966. Delta soils of southeast Missouri. Columbia: University of Missouri, Agricultural Experiment Station Bulletin 854.

Küchler, A. W. 1964. The potential natural vegetation of the conterminous United States. With map at 1:3,168,000. New York: American Geographical Society, Special Publication 36.

———. 1985. Potential natural vegetation. Rev. ed. Map at 1:7,500,000. In The national atlas of the United States of America, 89–91. Washington, D.C.: U.S. Geological Survey.

Liming, F. G. 1946. The range and distribution of shortleaf pine in Missouri. Columbus, Ohio: Central States Forest Experiment Station, Technical Paper no. 106.

Marbut, C. F. 1896. Physical features of Missouri. In Surface features of Missouri, pp. 11–109. Jefferson City: Missouri Geological Survey, vol. 10.

———. 1914. Soil reconnaissance of the Ozark region of Missouri and Arkansas. In Field operations of the Bureau of Soils, 1911, pp. 1727–1873 and map no. 41 (map at approx. 1:570,000). Washington, D.C.: U.S. Department of Agriculture, Bureau of Soils.

Maxwell, J. R., C. J. Edwards, M. E. Jensen, S. J. Paustian, H. Parrott, and D. M. Hill. 1995. A hierarchical framework of aquatic ecological units in North America (Nearctic zone). General Technical Report NC-176. St. Paul, Minn.: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station.

McBride, T. D. 1977. A landform map for Missouri. Map at 1:700,000. Master's thesis, University of Missouri–Columbia.

McNab, W. H., and P. E. Avers, comps. 1994. Ecological subregions of the United States: Section descriptions. Administrative Publication WO-WSA-5. Washington, D.C.: U.S. Department of Agriculture, Forest Service, Ecosystems Management.

Miller, M. R. 1981. Ecological land classification terrestrial subsystem: A basic inventory system for planning and management on the Mark Twain National Forest. Rolla, Mo.: U.S. Department of Agriculture, Forest Service, Eastern Region.

Nelson, P. 1983. The terrestrial natural communities of Missouri. Jefferson City: Missouri Department of Natural Resources.

———. 2002. (same as above) Revision, in progress.

Nigh, T. A., and S. K. Amelon. 1995. Missouri ecological classification system project plan. Jefferson City: Missouri Department of Conservation.

Nigh, T. A., C. Becker, J. Grabner, J. Kabrick, and D. Meinert. 2000. An ecological classification system for the Current River Hills Subsection. [Working Draft.] Jefferson City: Missouri Department of Conservation.

Omernik, J. M. 1987. Ecoregions of the conterminous United States. Map supplement (1986), at 1:7,500,000. Annals of the Association of American Geographers 77:118–25.

———. 1995. Ecoregions: A framework for environmental management. Pp. 49–62 in W. S. Davis and T. P. Simon, eds., Biological assessment and criteria: Tools for water resource planning and decision making. Boca Raton, Fla.: Lewis Publishers.

Omernik, J. M., S. S. Chapman, R. A. Lillie, and R. T. Dumke. 2000. Ecoregions of Wisconsin. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 88:77–103.

O'Neill, R. V., D. L. DeAngelis, J. B. Waide, and T. F. H. Allen. 1986. A hierarchical concept of ecosystems. Princeton: Princeton University Press.

Owenby, J. R., and D. S. Ezell. 1992. Monthly station normals of temperature, precipitation, and heating and cooling degree days, 1961–90: Missouri. Asheville, N.C.: National Climatic Data Center, Climatography of the United States no. 81.

Pater, D. E., S. A. Bryce, T. D. Thorson, J. Kagan, C. Chappell, J. M. Omernik, S. H. Azvedo, and A. J. Woods. 1998. Ecoregions of western Washington and Oregon. Map poster at 1:1,350,000. Reston, Va.: U.S. Geological Survey.

Pell, B. 1983. The natural divisions of Arkansas: A revised classification and description. Natural Areas Journal 3 (2): 12–23.

Porter, S. 1998. Modeling historic woody vegetation in the lower Ozarks of Missouri. Master's thesis, University of Missouri–Columbia.

Pratt, W. P., M. A. Middendorf, I. R. Satterfield, and P. E. Gerdemann. 1992. Geologic map of the Rolla 1° x 2° quadrangle, Missouri. Miscellaneous Investigation Series Map I-1998. Washington, D.C.: U.S. Geological Survey.

Prior, J. C. 1991. Landforms of Iowa. Iowa City: University of Iowa Press.

Richmond, G. M., and D. S. Fullerton, eds. 1991. Quaternary geologic map of the Louisville 4° x 6° quadrangle, United States. Miscellaneous Investigation Series Map I-1420 (NJ-16). Washington, D.C.: U.S. Geological Survey.

Richmond, G. M., D. S. Fullerton, and A. C. Christiansen, eds. 1991. Quaternary geologic map of the Des Moines 4° x 6° quadrangle, United States. Quaternary Geologic Atlas of the United States, Miscellaneous Investigation Series Map I-1420 (NK-15). Washington, D.C.: U.S. Geological Survey.

Richmond, G. M., and D. L. Weide, eds. 1993. Quaternary geologic map of the Ozark Plateau 4° x 6° quadrangle, United States. Quaternary Geologic Atlas of the United States, Miscellaneous Investigation Series Map I-1420 (NJ-15). Washington, D.C.: U.S. Geological Survey.

Saucier, R. T. 1994. Geomorphology and quaternary geologic history of the lower Mississippi Valley. Vicksburg, Miss.: U.S. Army Corps of Engineers.

Sauer, C. O. 1920. The geography of the Ozark highland of Missouri. Geographic Society of Chicago Bulletin no. 7. Chicago: University of Chicago Press. Reprint, New York: Greenwood Press, 1968.

Schoolcraft, H. R. 1821. Journal of a tour into the interior of Missouri and Arkansas performed in the years 1818 and 1819. London: Phillips.

Schottenloher, R. 1936. Das Ozarkland. In Amerikanische Landschaft, ed. E. von Drygalski, 1–125. Berlin and Leipzig: Geographisches Institut der Universität München, W. de Gruyter.

Schroeder, W. A. 1981a. Presettlement prairie of Missouri. Natural History Series no. 2. Jefferson City: Missouri Department of Conservation.

Schroeder, W. A. 1981b. Presettlement prairie of Missouri. Map at 1:500,000. Jefferson City: Missouri Department of Conservation.

Schroeder, W. A. 1982. Missouri water atlas. Jefferson City: Missouri Department of Natural Resources.

Schroeder, W. A. n.d. Landforms of Missouri. Manuscript. Department of Geography, University of Missouri–Columbia.

Schuette, B. 1979. Extension of Missouri's Ozark faunal region. Transactions of the Missouri Academy of Science 13:37–40.

Schwegman, J. E. n.d. The natural divisions of Illinois. Map at approx. 1:1,000,000. Developed by the Illinois Nature Preserves Commission. Springfield: Illinois Department of Conservation.

Scrivner, C. L., J. C. Baker, and B. J. Miller. 1975. Soils of Missouri. Columbia: University of Missouri, Cooperative Extension Service.

A state plan for Missouri: Water plan 1938. 1938. Jefferson City: Works Progress Administration, in cooperation with Missouri State Planning Board, Water Resources Committee.

Swallow, G. C. 1867. Physical geography of Missouri. Missouri State Board of Agriculture, Annual Report 2(1866), 58–96.

Thom, R. H., and J. H. Wilson. 1980. The natural divisions of Missouri. Transactions of the Missouri Academy of Science 14:9–23.

Thornbury, W. D. 1965. Regional geomorphology of the United States. New York: John Wiley and Sons.

U.S. Department of Agriculture, Soil Conservation Service. 1981. Land resource regions and major land resource areas of the United States. Rev. ed. Agricultural Handbook 296. Washington, D.C.: U.S. Department of Agriculture, Soil Conservation Service.

U.S. Department of Agriculture, Soil Conservation Service. 1994. State soil geographic data base (Statsgo). Fort Worth, Tex.: SCS National Cartography and GIS Center.

U.S. Department of Agriculture, Soil Conservation Service. Multiple dates. County soil surveys for most of Missouri's counties. Columbia: Missouri State Field Office.

Wendland W. M., K. E. Kunkel, G. Conner, W. L. Decker, H. Hillaker, P. Naber-Knox, F. V. Nurnberger, J. Rogers, K. Scheeringa, and J. Zandlo. 1992. Mean 1961–1990 temperature and precipitation over the Upper Midwest. Research Report 92–01, State Water Survey Miscellaneous Publication 136. Champaign, Ill.: Midwestern Climate Center.

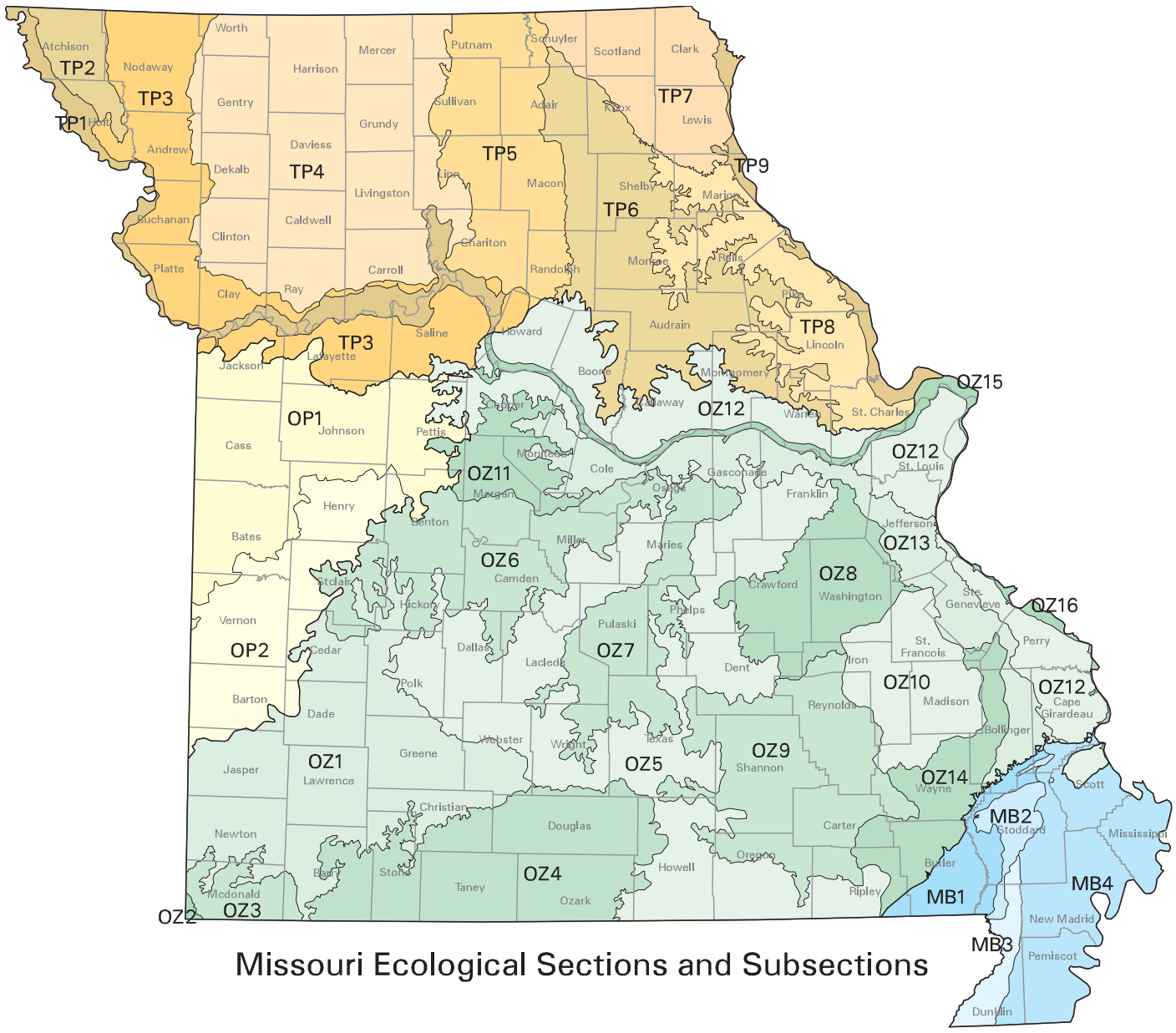
Whitfield, J. W. 1982. Surficial materials map of Missouri. Map at approx. 1:1,000,000. In Geologic aspects of individual home liquid-waste disposal in Missouri, by J. W. Duley, plate 3. Engineering Geology Report no. 7. Rolla: Missouri Department of Natural Resources, Division of Geology and Land Survey.

Woods, A. J., and J. M. Omernik. 1996. Ecoregions of Pennsylvania. Pennsylvania Geographer 34 (2): 3–37.

Woods, A. J., J. M. Omernik, C. S. Brockman, T. D. Gerber, W. D. Hosteter, and S. H. Azvedo. 1998. Ecoregions of Indiana and Ohio. Map poster at 1:1,500,000. Reston, Va.: U.S. Geological Survey.

Woods, A. J., J. M. Omernik, J. A. Nesser, J. Shelden, and S. H. Azvedo. 1999. Ecoregions of Montana. Map poster at 1:1,500,000. Reston, Va.: U.S. Geological Survey.

Yatskievych, G. 1999. An overview of Missouri. In Steyermark's Flora of Missouri, 1:43–76. Jefferson City: Missouri Department of Conservation.



Missouri Ecological Sections and Subsections

List of Sections, Subsections and Landtype Associations (LTAs)